METHODOLOGY, SYSTEM, COMPUTER READABLE MEDIUM, AND PRODUCT PROVIDING A SECURITY SOFTWARE SUITE
FOR HANDLING OPERATING SYSTEM EXPLOITATIONS
Applicant: Sandra E. Ring et al.
Serial No.: 10/789,460
Docket No.: 2037

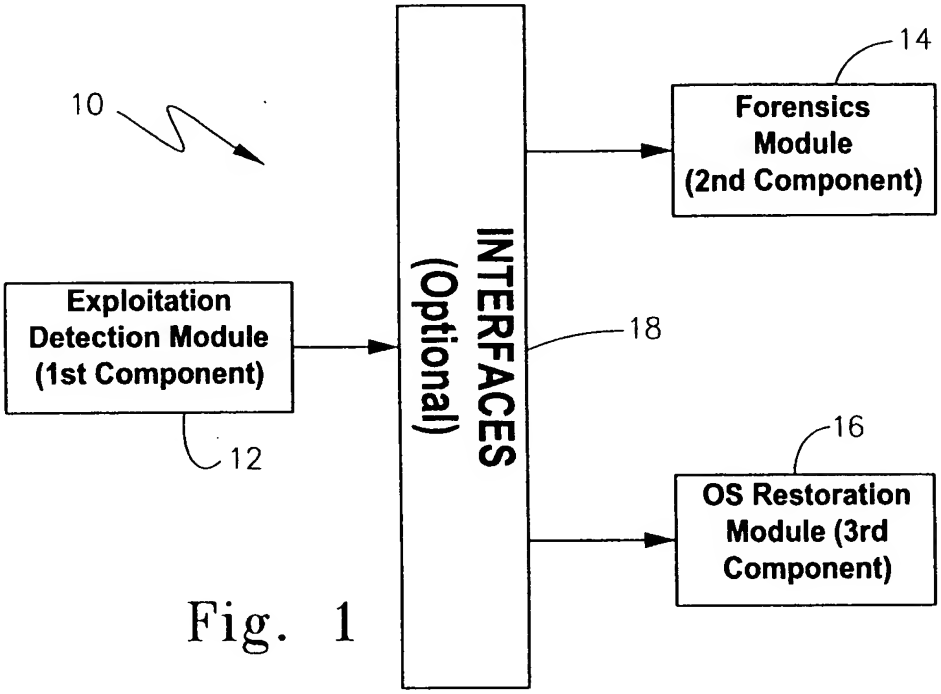

10
Exploitation Detection Module (1st Component)
12
INTERFACES (Optional)
18
14
Forensics Module (2nd Component)
16
OS Restoration Module (3rd Component)

Fig. 1

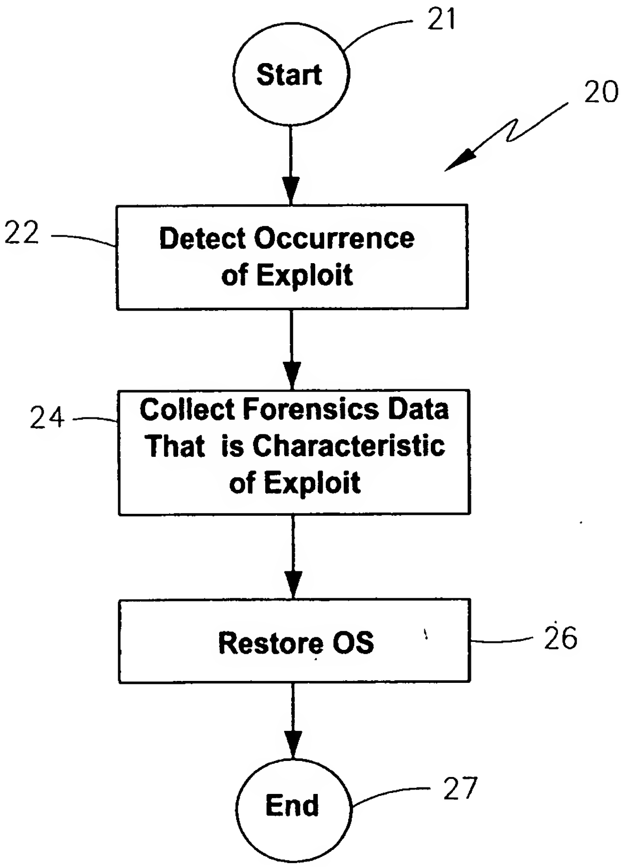

21
Start
20
22
Detect Occurrence of Exploit
24
Collect Forensics Data That is Characteristic of Exploit
Restore OS
26
End
27

Fig. 2

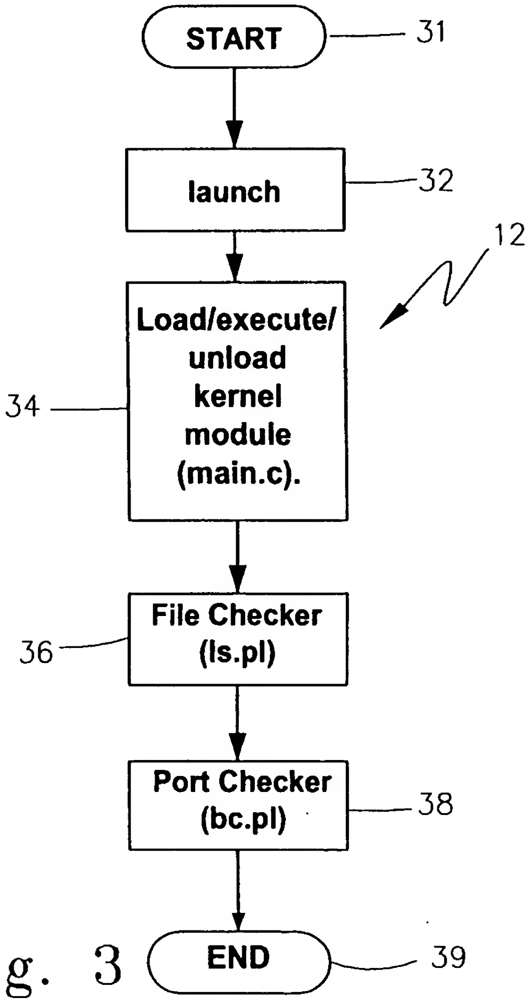


Fig. 3

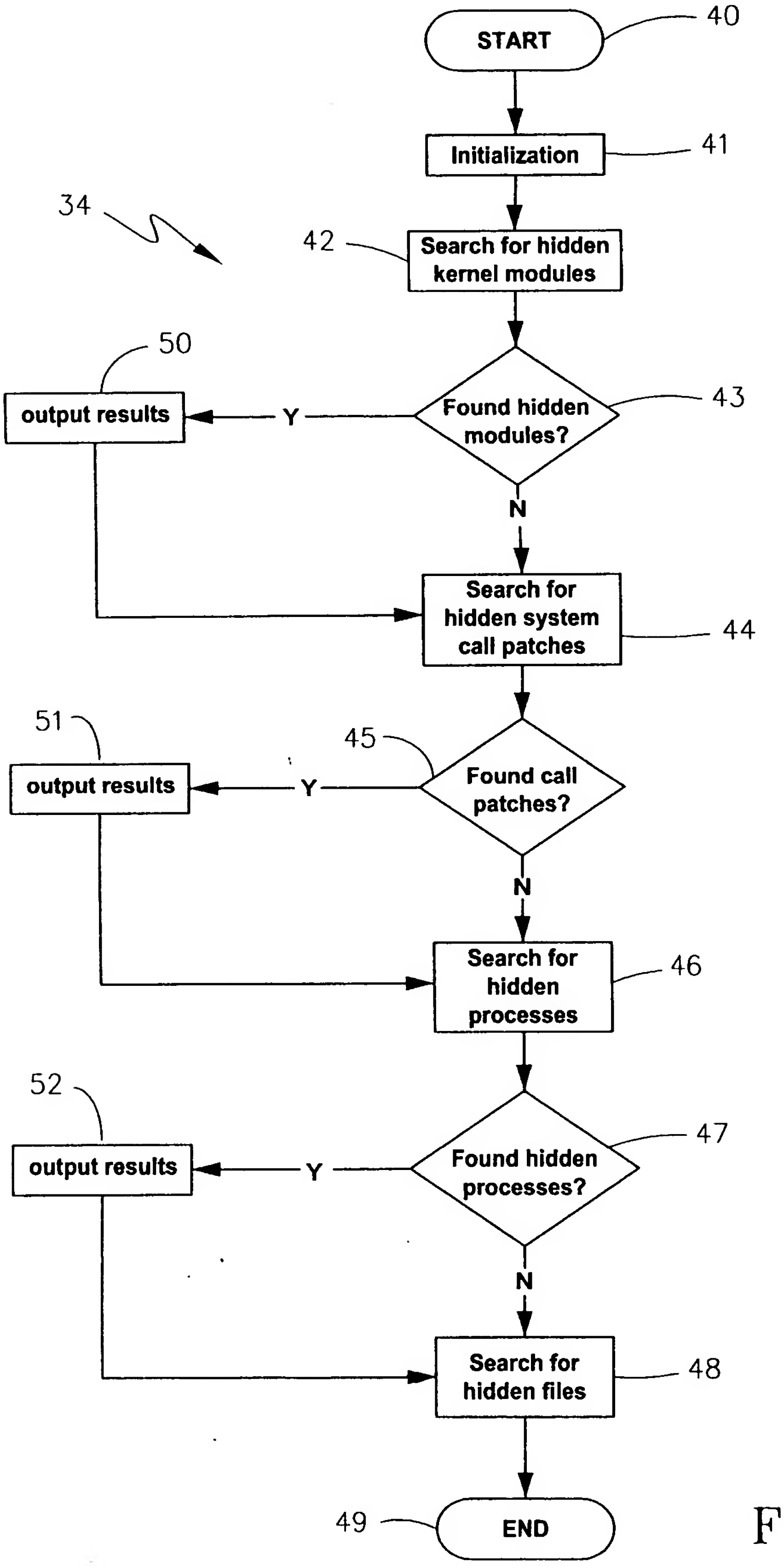

START
40
Initialization
41
34
42
Search for hidden kernel modules
50
output results
Y
Found hidden modules?
43
N
Search for hidden system call patches
44
51
45
output results
Y
Found call patches?
N
Search for hidden processes
46
52
output results
Y
Found hidden processes?
47
N
Search for hidden files
48
49
END

Fig.4

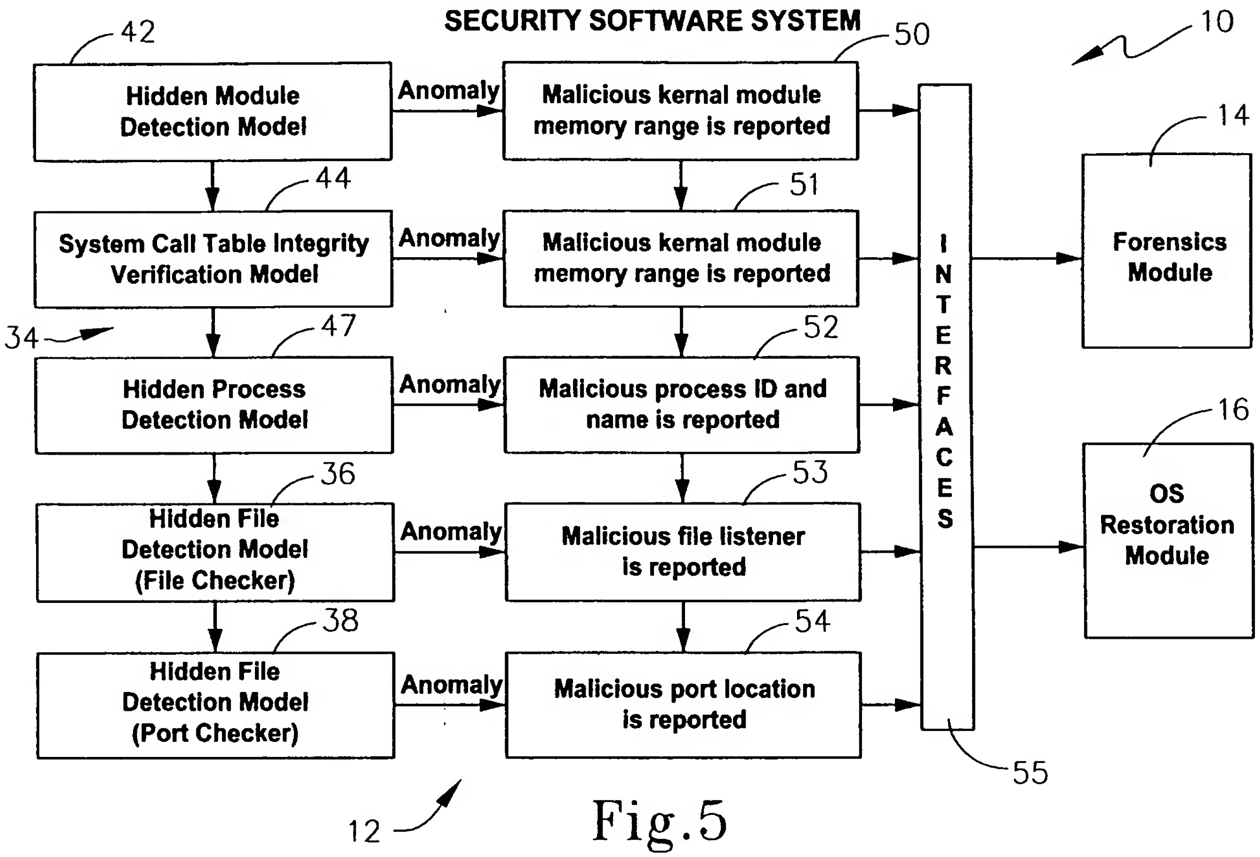

SECURITY SOFTWARE SYSTEM
10
42
Hidden Module Detection Model
Anomaly
50
Malicious kernal module memory range is reported
44
System Call Table Integrity Verification Model
Anomaly
51
Malicious kernal module memory range is reported
34
47
Hidden Process Detection Model
Anomaly
52
Malicious process ID and name is reported
36
Hidden File Detection Model (File Checker)
Anomaly
53
Malicious file listener is reported
38
Hidden File Detection Model (Port Checker)
Anomaly
54
Malicious port location is reported
INTERFACES
55
14
Forensics Module
16
OS Restoration Module
12

Fig.5

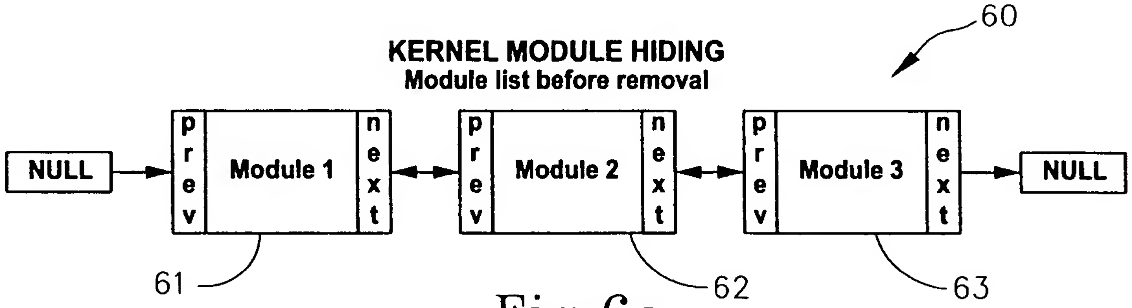


Fig.6a

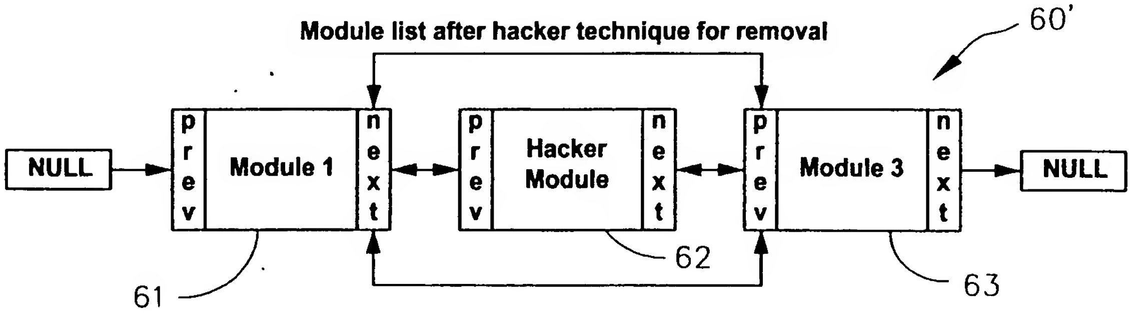


Fig.6b

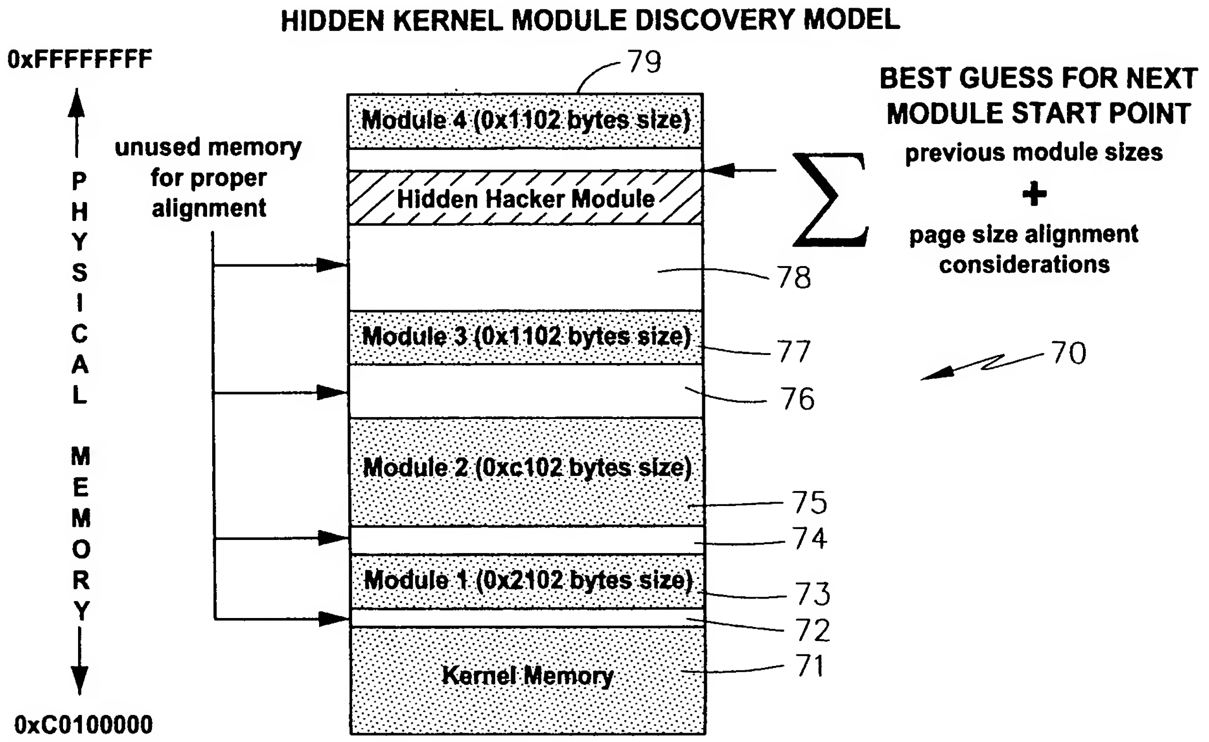
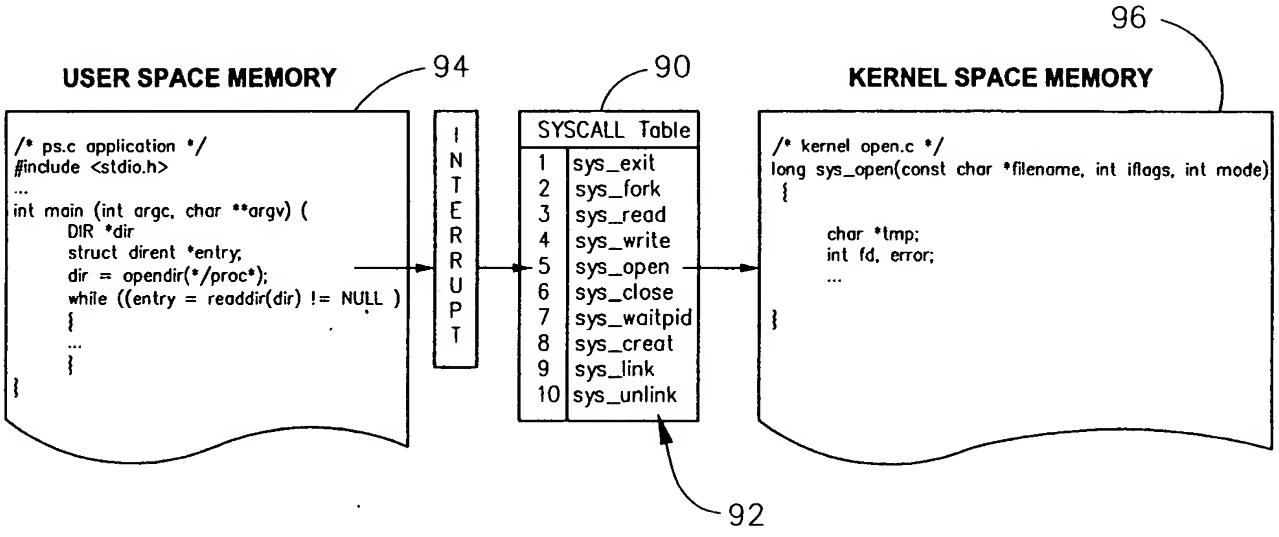

HIDDEN KERNEL MODULE DISCOVERY MODEL
0xFFFFFFFF
PHYSICAL MEMORY
0xC0100000
unused memory for proper alignment
79
Module 4 (0x1102 bytes size)
Hidden Hacker Module
78
Module 3 (0x1102 bytes size)
77
76
Module 2 (0xc102 bytes size)
75
74
Module 1 (0x2102 bytes size)
73
72
Kernel Memory
71
BEST GUESS FOR NEXT MODULE START POINT
∑ previous module sizes
+
page size alignment considerations
70

Fig.7



```
/* ps.c application */
#include <stdio.h>
...
int main (int argc, char **argv) (
        DIR *dir
        struct dirent *entry;
        dir = opendir("/proc");
        while ((entry = readdir(dir) != NULL )
        {
        ...
        }
}
```

SYSCALL Table	
1	sys_exit
2	sys_fork
3	sys_read
4	sys_write
5	sys_open
6	sys_close
7	sys_waitpid
8	sys_creat
9	sys_link
10	sys_unlink

```
/* kernel open.c */
long sys_open(const char *filename, int iflags, int mode)
 {

        char *tmp;
        int fd, error;
        ...

}
```

Fig.9

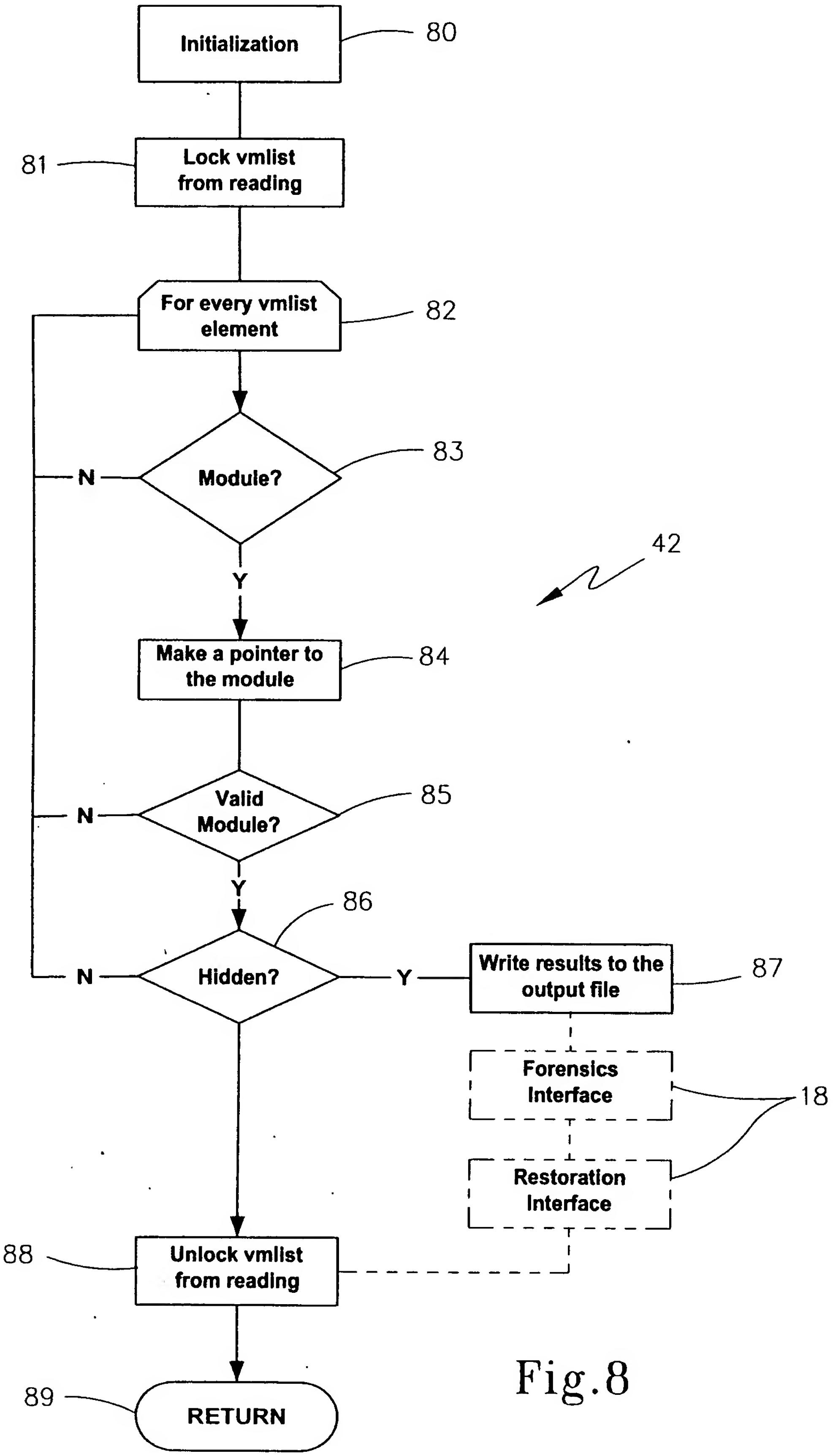

Initialization
80
81
Lock vmlist from reading
For every vmlist element
82
Module?
83
N
Y
42
Make a pointer to the module
84
Valid Module?
85
N
Y
86
Hidden?
N
Y
Write results to the output file
87
Forensics Interface
Restoration Interface
18
88
Unlock vmlist from reading
89
RETURN

Fig.8

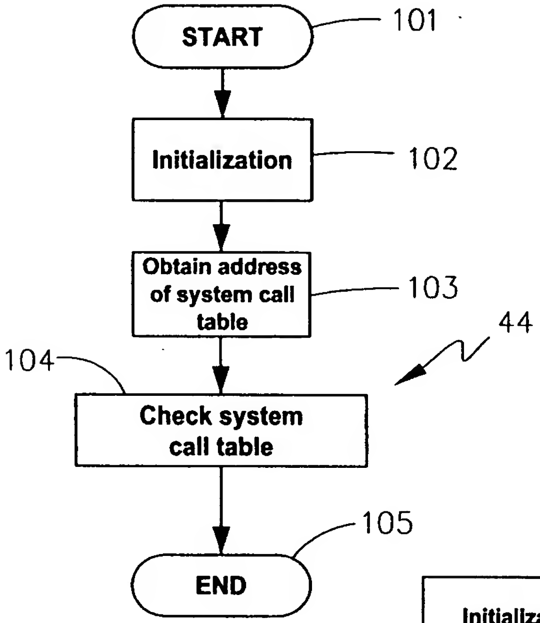


Fig.10a

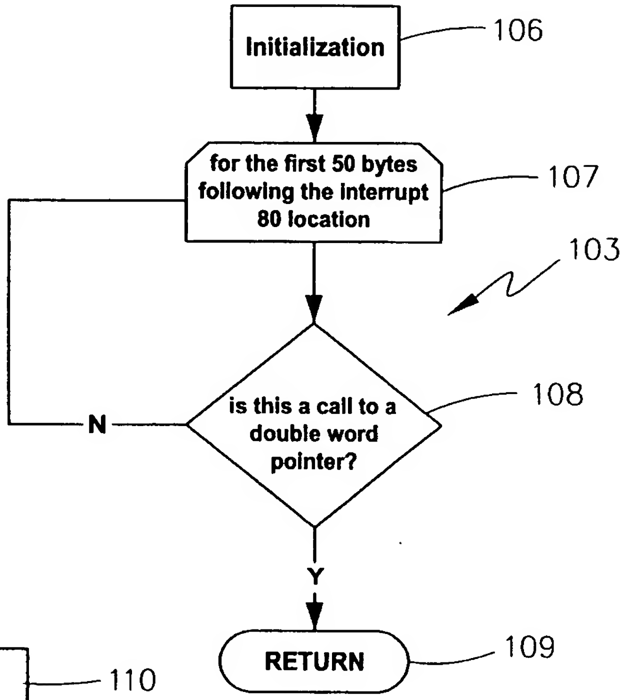

Initialization
106
for the first 50 bytes following the interrupt 80 location
107
103
is this a call to a double word pointer?
108
N
Y
RETURN
109

Fig.10b

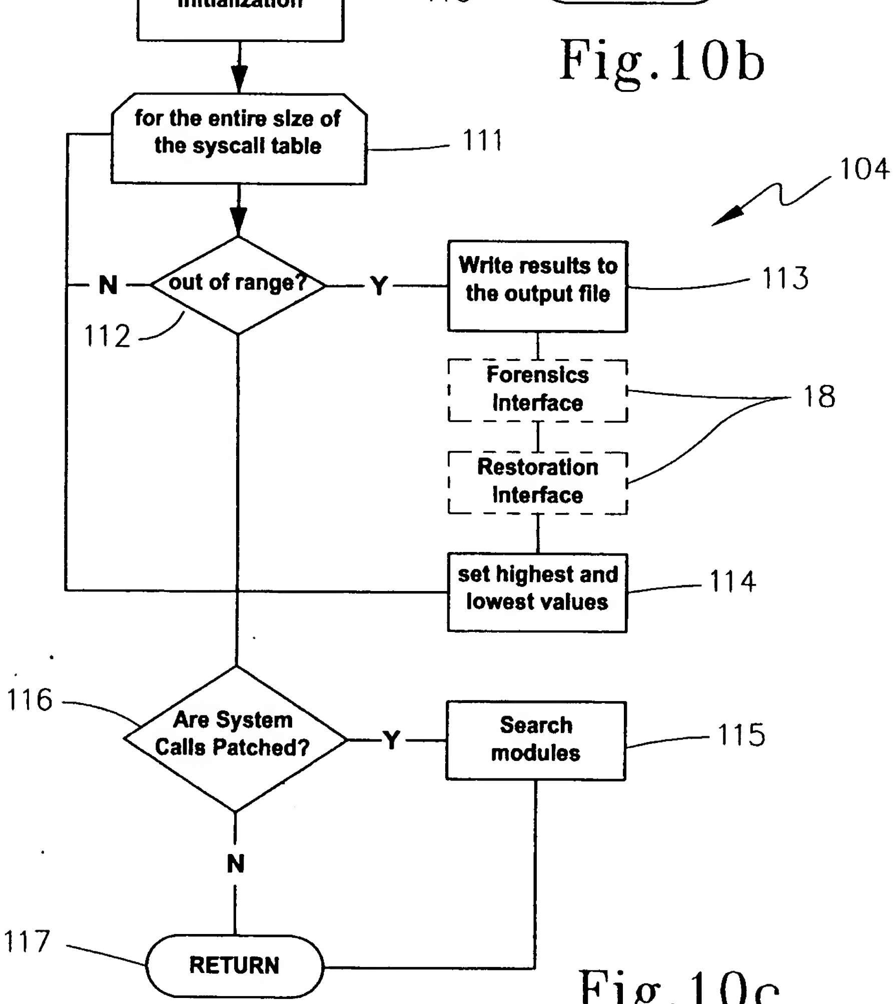

Initialization
110
for the entire size of the syscall table
111
104
N
out of range?
Y
112
Write results to the output file
113
Forensics Interface
18
Restoration Interface
set highest and lowest values
114
116
Are System Calls Patched?
Y
Search modules
115
N
117
RETURN

Fig.10c

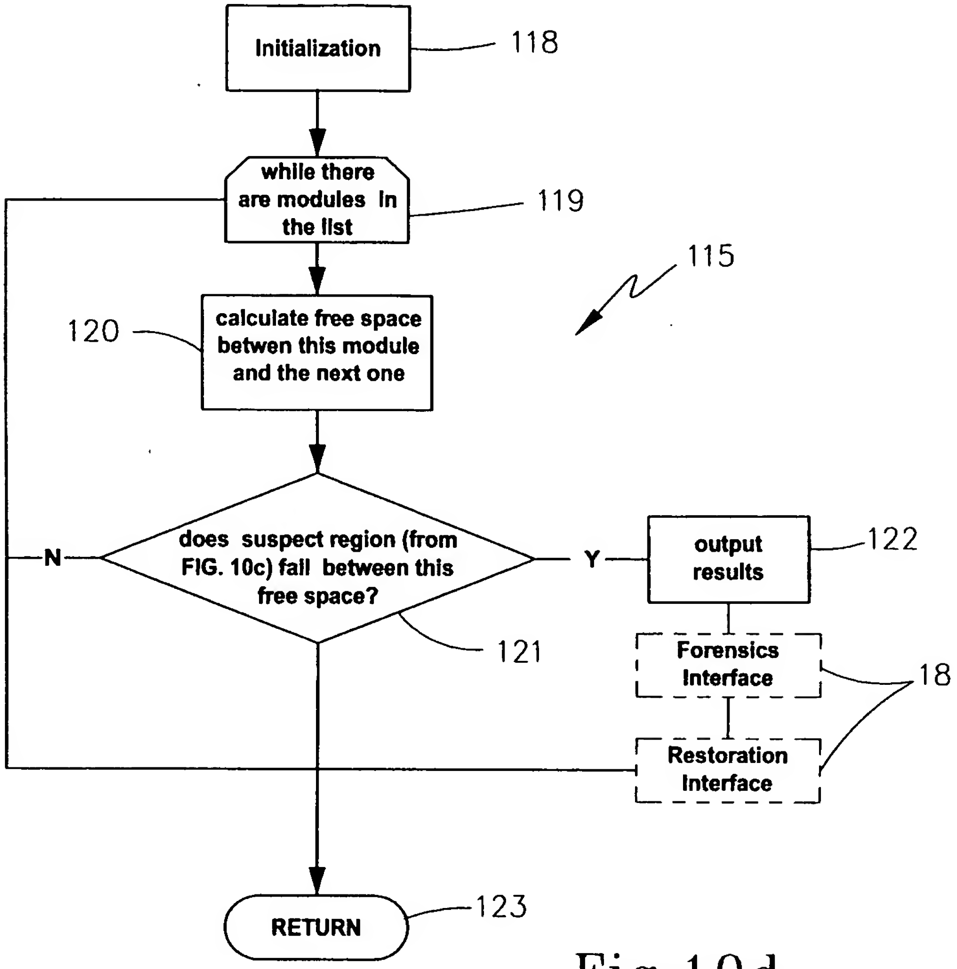
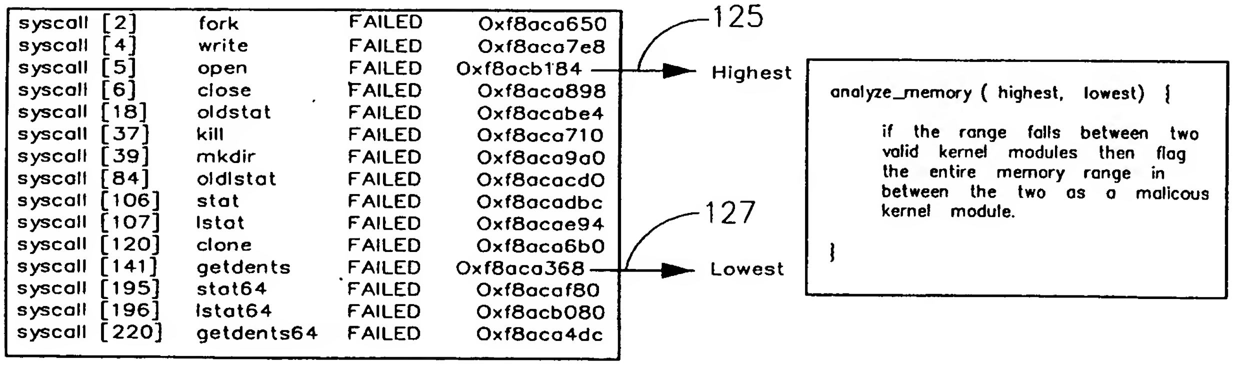

Initialization
118
while there are modules in the list
119
115
calculate free space betwen this module and the next one
120
does suspect region (from FIG. 10c) fall between this free space?
121
N
Y
output results
122
Forensics Interface
Restoration Interface
18
RETURN
123

Fig.10d

IDENTIFIED SYSCALL ANOMALIES CAUSE BY ADORE v0.42



```
syscall [2]     fork        FAILED    0xf8aca650
syscall [4]     write       FAILED    0xf8aca7e8
syscall [5]     open        FAILED   0xf8acb184
syscall [6]     close       FAILED    0xf8aca898
syscall [18]    oldstat     FAILED    0xf8acabe4
syscall [37]    kill        FAILED    0xf8aca710
syscall [39]    mkdir       FAILED    0xf8aca9a0
syscall [84]    oldlstat    FAILED    0xf8acacd0
syscall [106]   stat        FAILED    0xf8acadbc
syscall [107]   lstat       FAILED    0xf8acae94
syscall [120]   clone       FAILED    0xf8aca6b0
syscall [141]   getdents    FAILED   0xf8aca368
syscall [195]   stat64      FAILED    0xf8acaf80
syscall [196]   lstat64     FAILED    0xf8acb080
syscall [220]   getdents64  FAILED    0xf8aca4dc
```

```
analyze_memory ( highest, lowest) {

    if the range falls between two
    valid kernel modules then flag
    the entire memory range in
    between the two as a malicous
    kernel module.

}
```

Fig.11

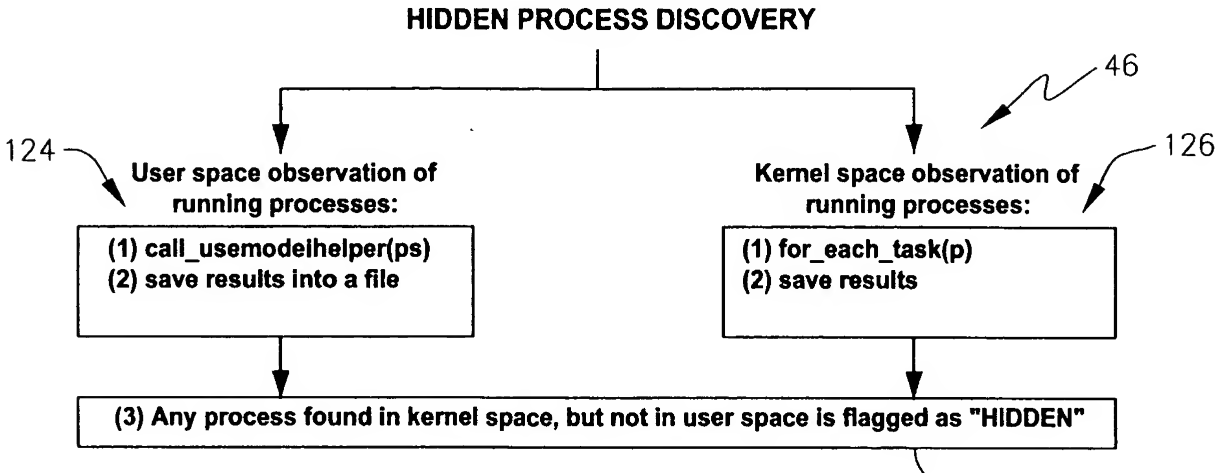

HIDDEN PROCESS DISCOVERY
46
124
User space observation of running processes:
(1) call_usemodelhelper(ps)
(2) save results into a file
126
Kernel space observation of running processes:
(1) for_each_task(p)
(2) save results
(3) Any process found in kernel space, but not in user space is flagged as "HIDDEN"
128

Fig.12

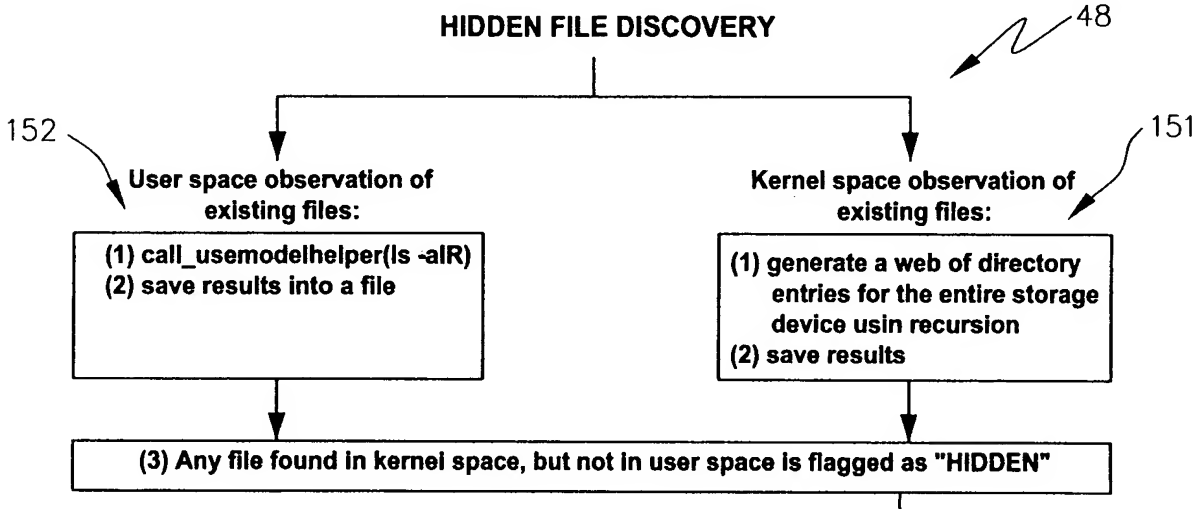

HIDDEN FILE DISCOVERY
48
152
User space observation of existing files:
(1) call_usemodelhelper(ls -alR)
(2) save results into a file
151
Kernel space observation of existing files:
(1) generate a web of directory entries for the entire storage device usin recursion
(2) save results
(3) Any file found in kernel space, but not in user space is flagged as "HIDDEN"
153

Fig.15

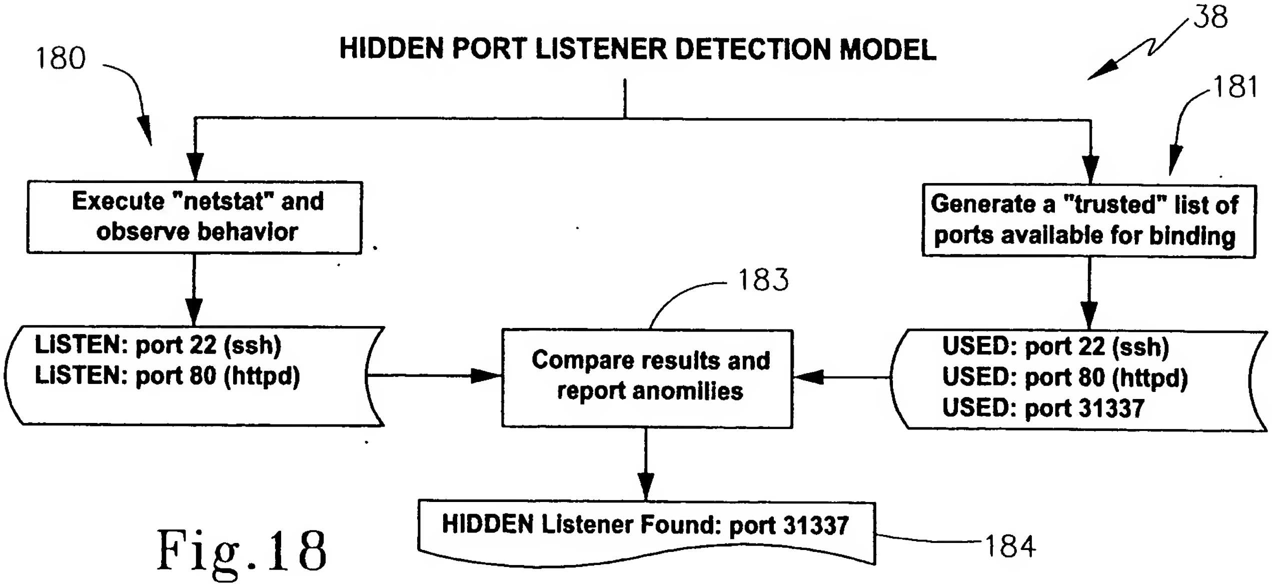

HIDDEN PORT LISTENER DETECTION MODEL
38
180
181
Execute "netstat" and observe behavior
Generate a "trusted" list of ports available for binding
183
LISTEN: port 22 (ssh)
LISTEN: port 80 (httpd)
Compare results and report anomilies
USED: port 22 (ssh)
USED: port 80 (httpd)
USED: port 31337
HIDDEN Listener Found: port 31337
184

Fig.18

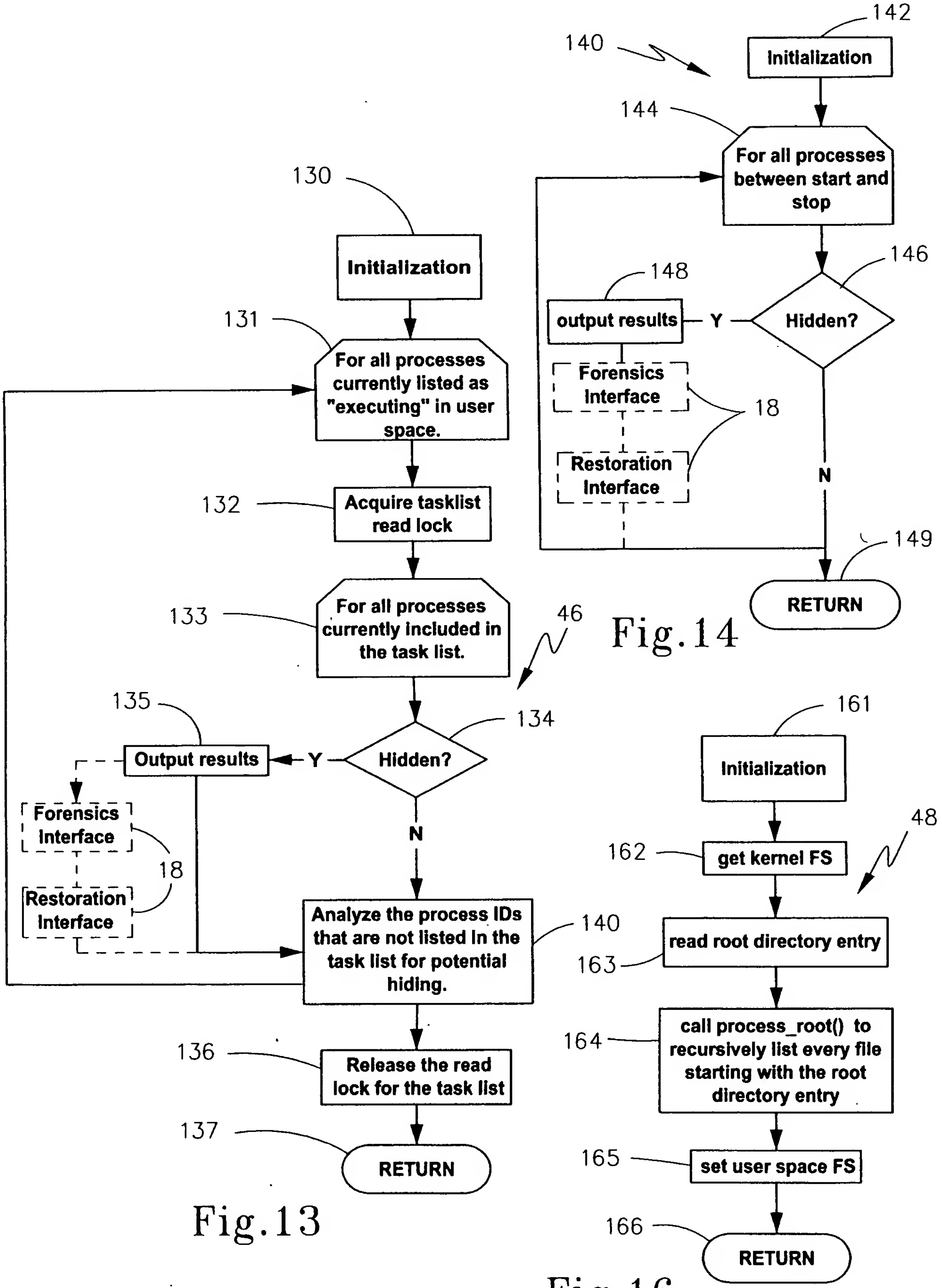

140
142
Initialization
144
For all processes between start and stop
146
Hidden?
148
output results
Y
Forensics Interface
18
Restoration Interface
N
149
RETURN
130
Initialization
131
For all processes currently listed as "executing" in user space.
132
Acquire tasklist read lock
133
For all processes currently included in the task list.
46
134
Hidden?
135
Output results
Y
Forensics Interface
18
Restoration Interface
N
Analyze the process IDs that are not listed in the task list for potential hiding.
140
136
Release the read lock for the task list
137
RETURN
161
Initialization
48
162
get kernel FS
163
read root directory entry
164
call process_root() to recursively list every file starting with the root directory entry
165
set user space FS
166
RETURN

Fig.14

Fig.13

Fig.16

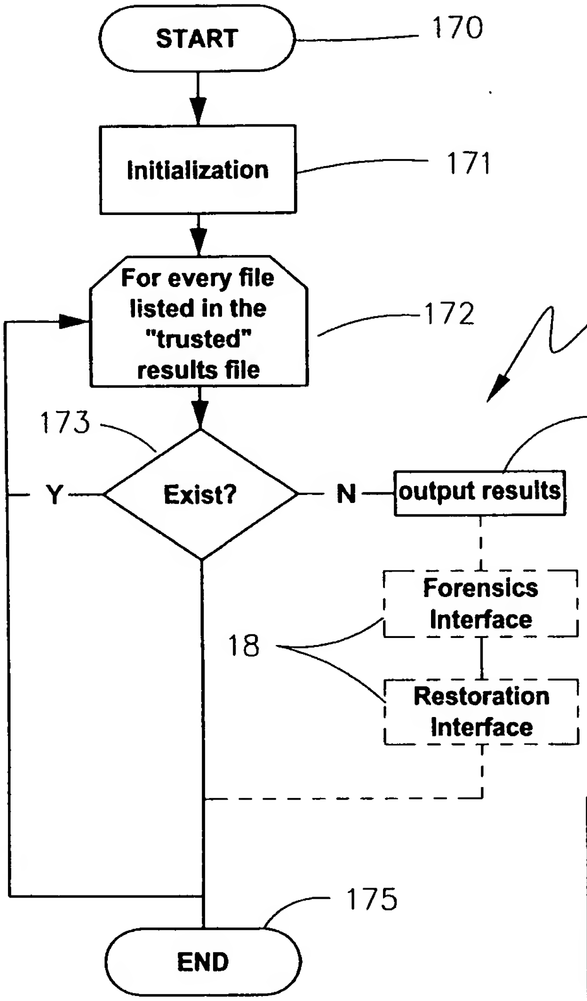

START
170
Initialization
171
For every file listed in the "trusted" results file
172
36
173
Exist?
Y
N
output results
174
Forensics Interface
18
Restoration Interface
175
END

Fig. 17

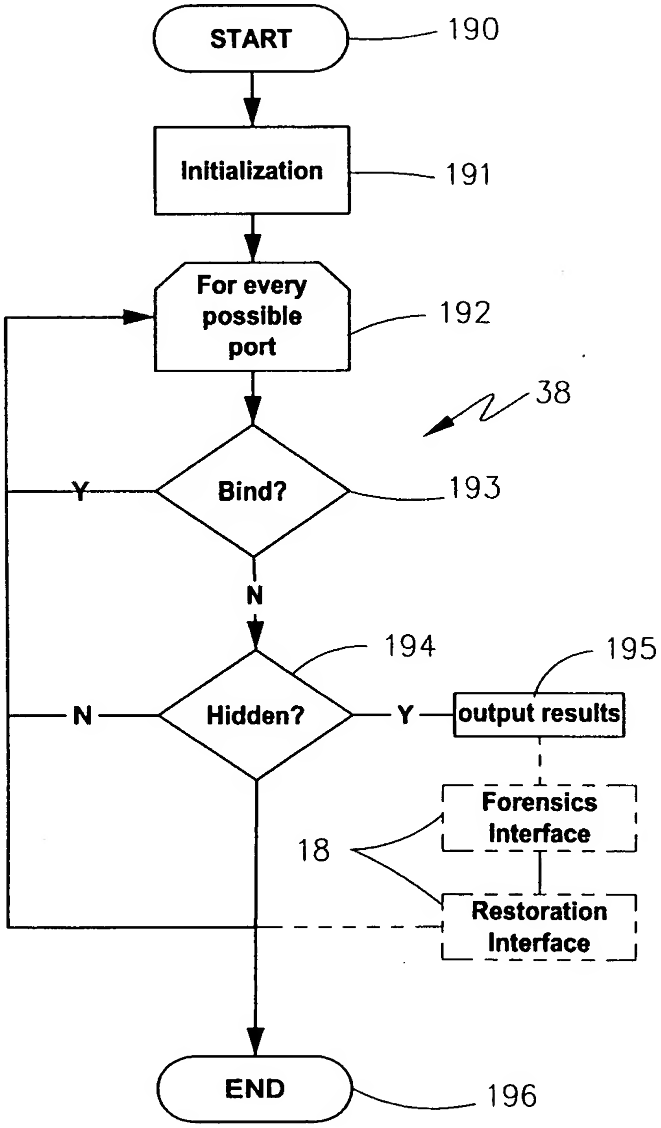
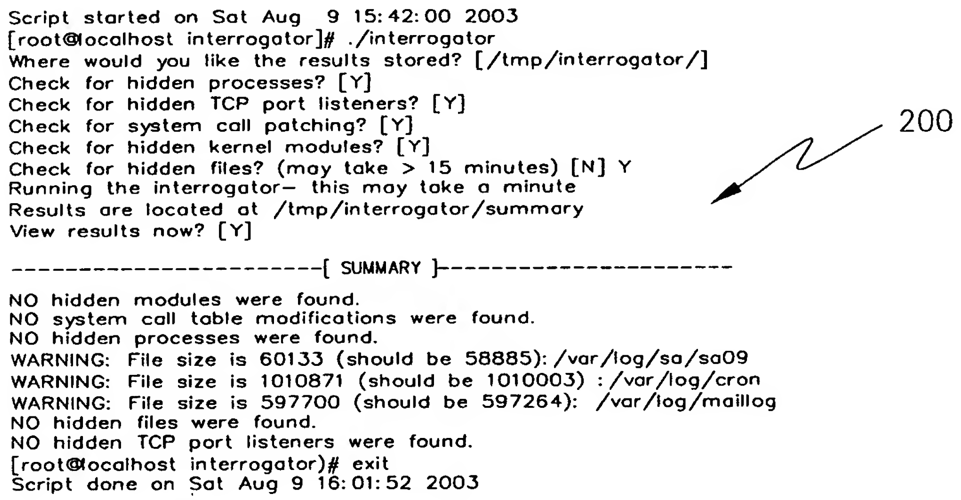
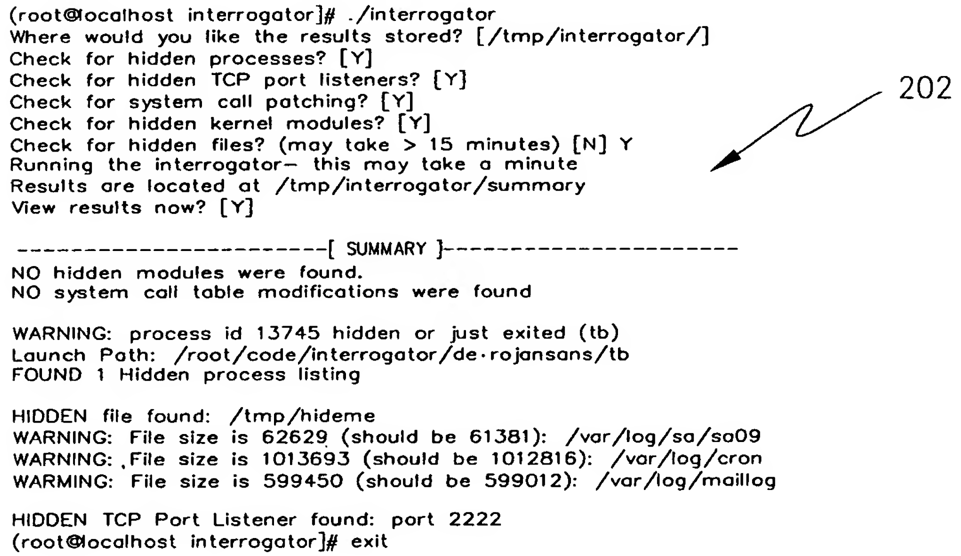

START
190
Initialization
191
For every possible port
192
38
Bind?
193
Y
N
194
Hidden?
N
Y
output results
195
Forensics Interface
18
Restoration Interface
END
196

FIG. 19



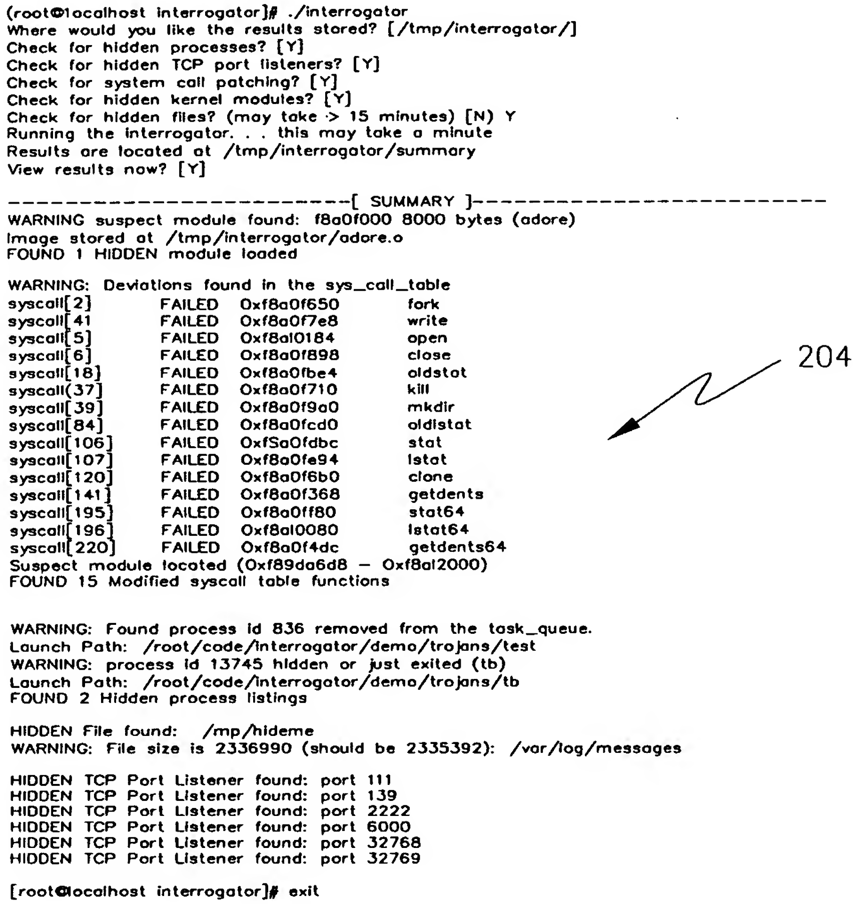
```
Script started on Sat Aug  9 15:42:00 2003
[root@localhost interrogator]# ./interrogator
Where would you like the results stored? [/tmp/interrogator/]
Check for hidden processes? [Y]
Check for hidden TCP port listeners? [Y]
Check for system call patching? [Y]
Check for hidden kernel modules? [Y]
Check for hidden files? (may take > 15 minutes) [N] Y
Running the interrogator— this may take a minute
Results are located at /tmp/interrogator/summary
View results now? [Y]

-----------------------[ SUMMARY ]----------------------

NO hidden modules were found.
NO system call table modifications were found.
NO hidden processes were found.
WARNING: File size is 60133 (should be 58885): /var/log/sa/sa09
WARNING: File size is 1010871 (should be 1010003) : /var/log/cron
WARNING: File size is 597700 (should be 597264):  /var/log/maillog
NO hidden files were found.
NO hidden TCP port listeners were found.
[root@localhost interrogator)# exit
Script done on Sat Aug 9 16:01:52 2003
```

Fig.20a



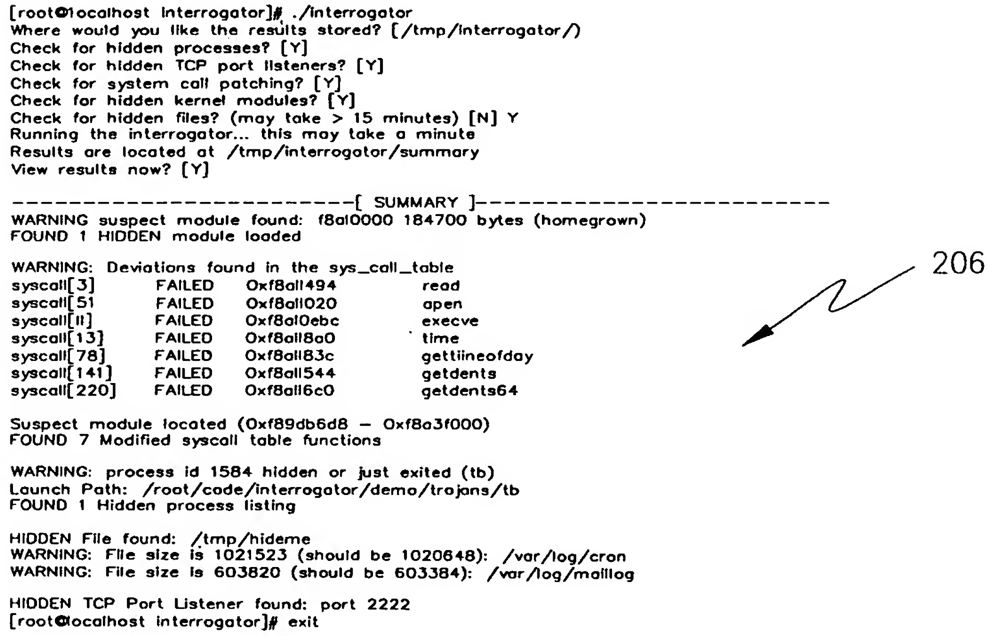
```
(root@localhost interrogator]# ./interrogator
Where would you like the results stored? [/tmp/interrogator/]
Check for hidden processes? [Y]
Check for hidden TCP port listeners? [Y]
Check for system call patching? [Y]
Check for hidden kernel modules? [Y]
Check for hidden files? (may take > 15 minutes) [N] Y
Running the interrogator— this may take a minute
Results are located at /tmp/interrogator/summary
View results now? [Y]

 -----------------------[ SUMMARY ]----------------------
NO hidden modules were found.
NO system call table modifications were found

WARNING: process id 13745 hidden or just exited (tb)
Launch Path: /root/code/interrogator/de·rojansans/tb
FOUND 1 Hidden process listing

HIDDEN file found: /tmp/hideme
WARNING: File size is 62629 (should be 61381): /var/log/sa/sa09
WARNING: File size is 1013693 (should be 1012816): /var/log/cron
WARMING: File size is 599450 (should be 599012): /var/log/maillog

HIDDEN TCP Port Listener found: port 2222
(root@localhost interrogator]# exit
```

Fig.20b



```
(root@localhost interrogator]# ./interrogator
Where would you like the results stored? [/tmp/interrogator/]
Check for hidden processes? [Y]
Check for hidden TCP port listeners? [Y]
Check for system call patching? [Y]
Check for hidden kernel modules? [Y]
Check for hidden files? (may take > 15 minutes) [N) Y
Running the interrogator. . . this may take a minute
Results are located at /tmp/interrogator/summary
View results now? [Y]

------------------------[ SUMMARY ]------------------------
WARNING suspect module found: f8a0f000 8000 bytes (adore)
Image stored at /tmp/interrogator/adore.o
FOUND 1 HIDDEN module loaded

WARNING: Deviations found in the sys_call_table
syscall[2]       FAILED   0xf8a0f650       fork
syscall[41       FAILED   0xf8a0f7e8       write
syscall[5]       FAILED   0xf8a10184       open
syscall[6]       FAILED   0xf8a0f898       close
syscall[18]      FAILED   0xf8a0fbe4       oldstat
syscall(37]      FAILED   0xf8a0f710       kill
syscall[39]      FAILED   0xf8a0f9a0       mkdir
syscall[84]      FAILED   0xf8a0fcd0       oldlstat
syscall[106]     FAILED   0xfSa0fdbc       stat
syscall[107]     FAILED   0xf8a0fe94       lstat
syscall[120]     FAILED   0xf8a0f6b0       clone
syscall[141]     FAILED   0xf8a0f368       getdents
syscall[195]     FAILED   0xf8a0ff80       stat64
syscall[196]     FAILED   0xf8a10080       lstat64
syscall[220]     FAILED   0xf8a0f4dc       getdents64
Suspect module located (0xf89da6d8 - 0xf8a12000)
FOUND 15 Modified syscall table functions


WARNING: Found process id 836 removed from the task_queue.
Launch Path: /root/code/interrogator/demo/trojans/test
WARNING: process id 13745 hidden or just exited (tb)
Launch Path: /root/code/interrogator/demo/trojans/tb
FOUND 2 Hidden process listings

HIDDEN File found:  /mp/hideme
WARNING: File size is 2336990 (should be 2335392): /var/log/messages

HIDDEN TCP Port Listener found: port 111
HIDDEN TCP Port Listener found: port 139
HIDDEN TCP Port Listener found: port 2222
HIDDEN TCP Port Listener found: port 6000
HIDDEN TCP Port Listener found: port 32768
HIDDEN TCP Port Listener found: port 32769

[root@localhost interrogator]# exit
```

Fig.20c



```
[root@localhost Interrogator]# ./interrogator
Where would you like the results stored? [/tmp/interrogator/)
Check for hidden processes? [Y]
Check for hidden TCP port listeners? [Y]
Check for system call patching? [Y]
Check for hidden kernel modules? [Y]
Check for hidden files? (may take > 15 minutes) [N] Y
Running the interrogator... this may take a minute
Results are located at /tmp/interrogator/summary
View results now? [Y]

------------------------[ SUMMARY ]------------------------
WARNING suspect module found: f8a10000 184700 bytes (homegrown)
FOUND 1 HIDDEN module loaded

WARNING: Deviations found in the sys_call_table
syscall[3]      FAILED    0xf8a11494          read
syscall[51      FAILED    0xf8a11020          open
syscall[ll]     FAILED    0xf8a10ebc          execve
syscall[13]     FAILED    0xf8a118a0          time
syscall[78]     FAILED    0xf8a1183c          gettiineofday
syscall[141]    FAILED    0xf8a11544          getdents
syscall[220]    FAILED    0xf8a116c0          getdents64

Suspect module located (0xf89db6d8 - 0xf8a3f000)
FOUND 7 Modified syscall table functions

WARNING: process id 1584 hidden or just exited (tb)
Launch Path: /root/code/interrogator/demo/trojans/tb
FOUND 1 Hidden process listing

HIDDEN File found: /tmp/hideme
WARNING: File size is 1021523 (should be 1020648): /var/log/cron
WARNING: File size is 603820 (should be 603384): /var/log/maillog

HIDDEN TCP Port Listener found: port 2222
[root@localhost interrogator]# exit
```

Fig.20d

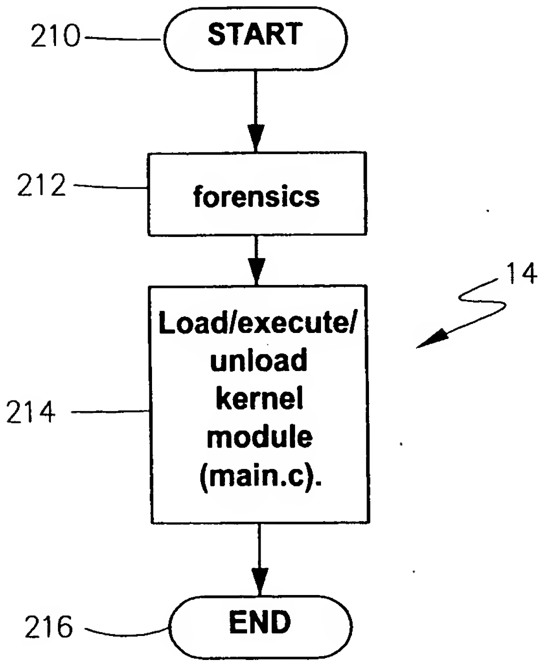


Fig. 21

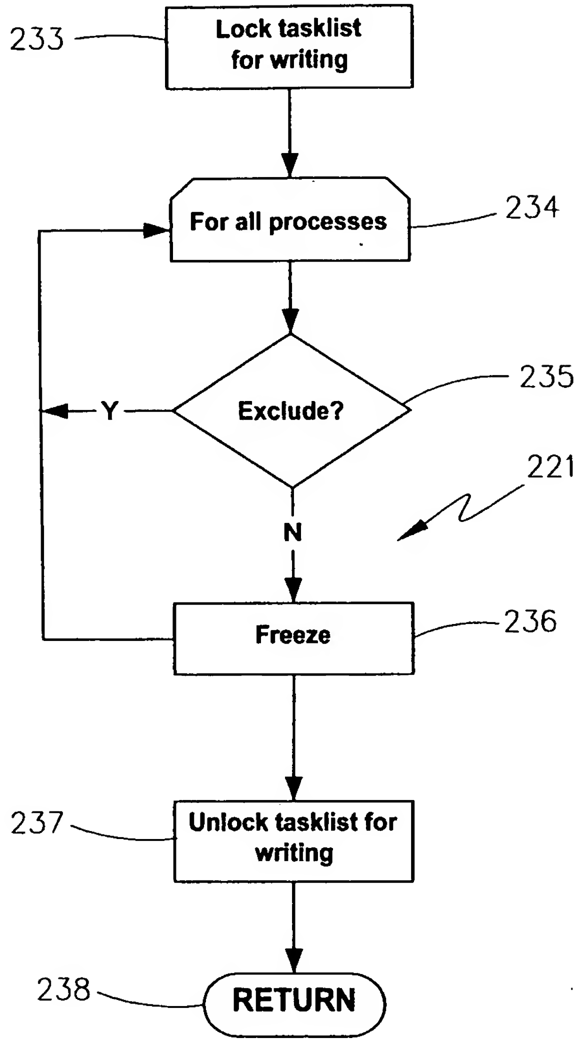


Fig. 23

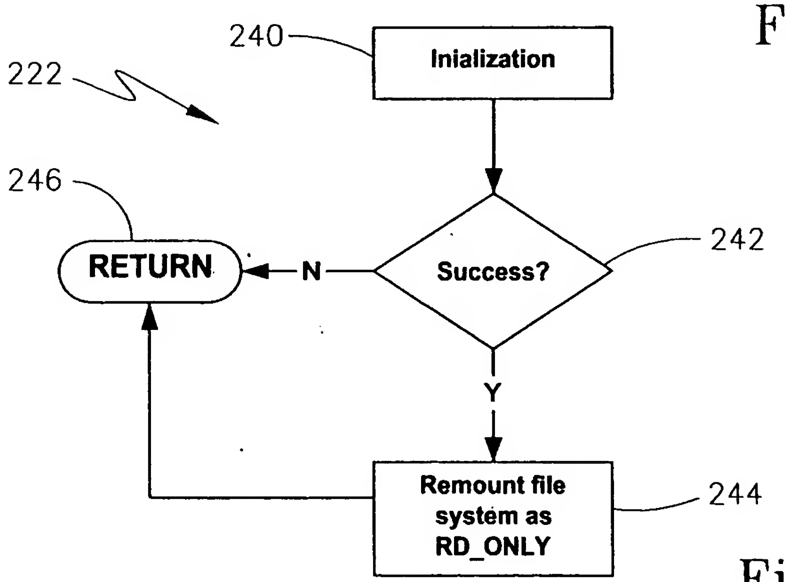


Fig. 24

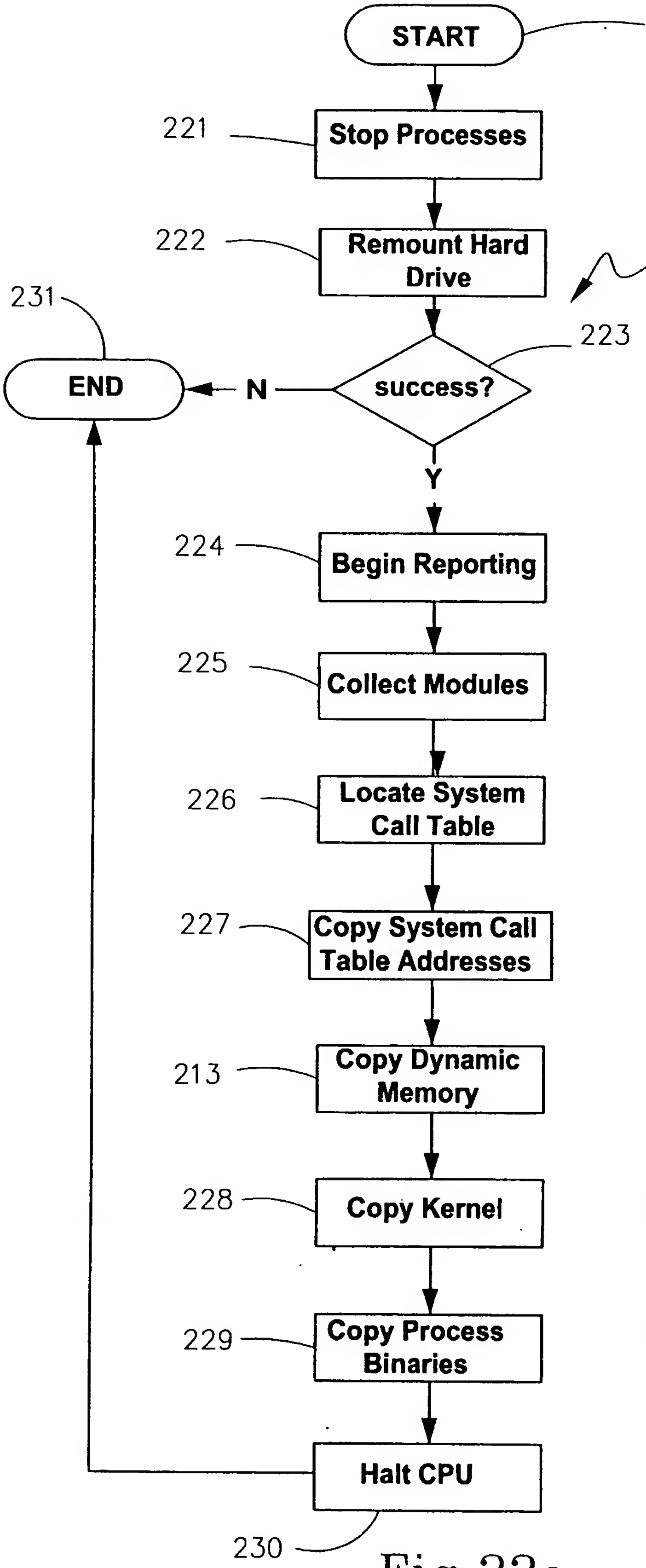


Fig.22a

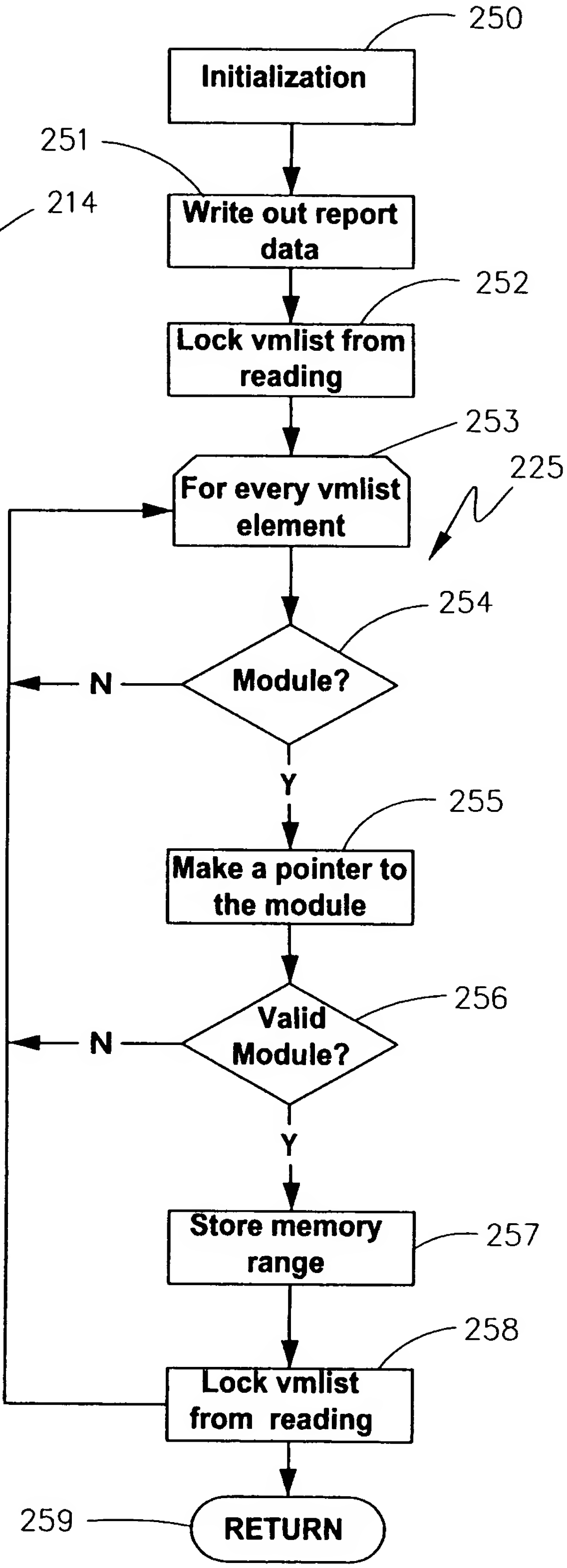


Fig.25a

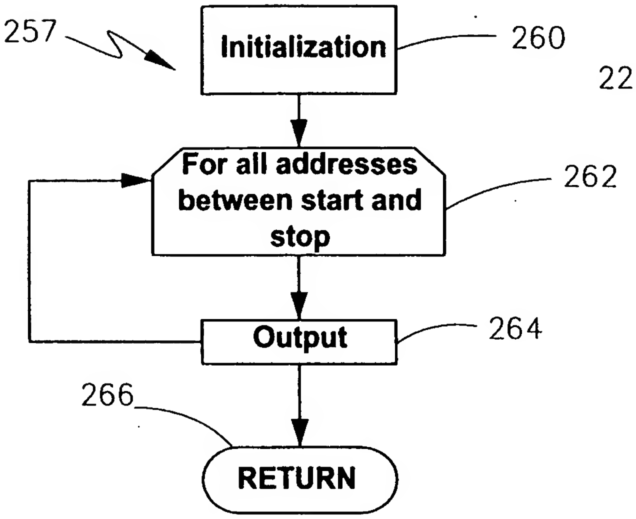


Fig.26

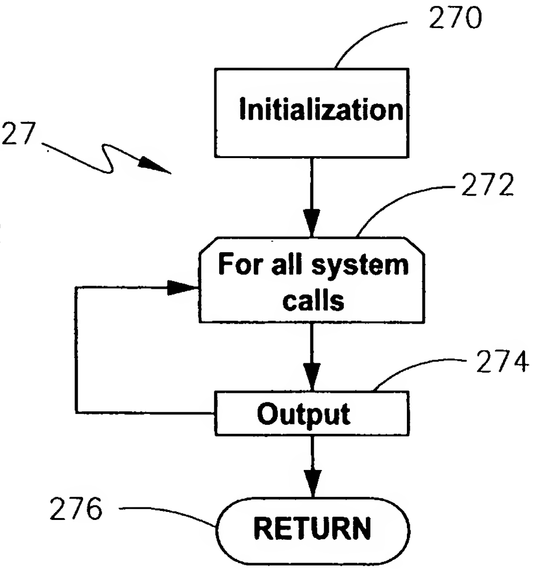


Fig.27a

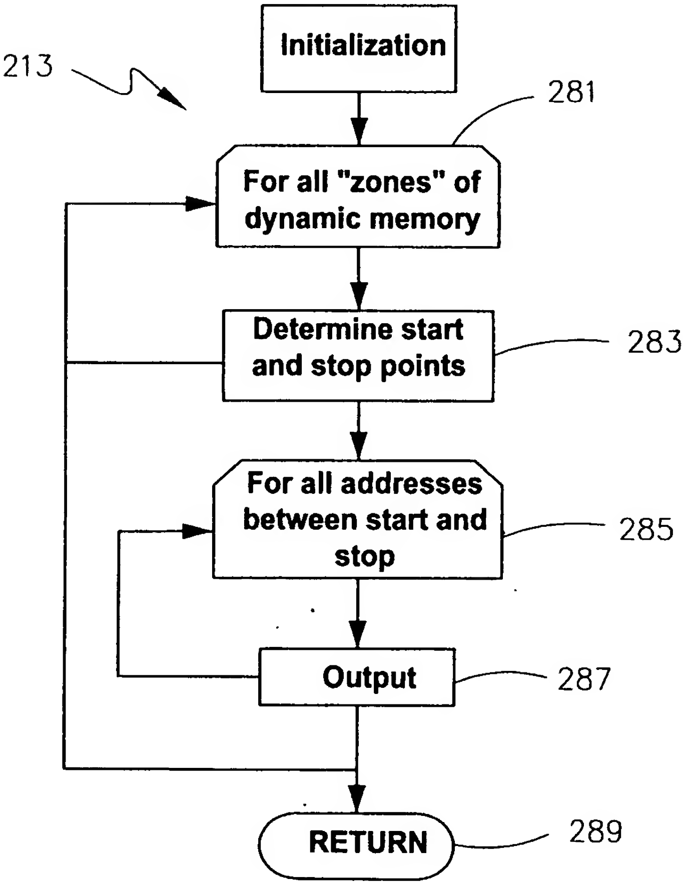

213
Initialization
281
For all "zones" of dynamic memory
Determine start and stop points
283
For all addresses between start and stop
285
Output
287
RETURN
289

Fig.28a

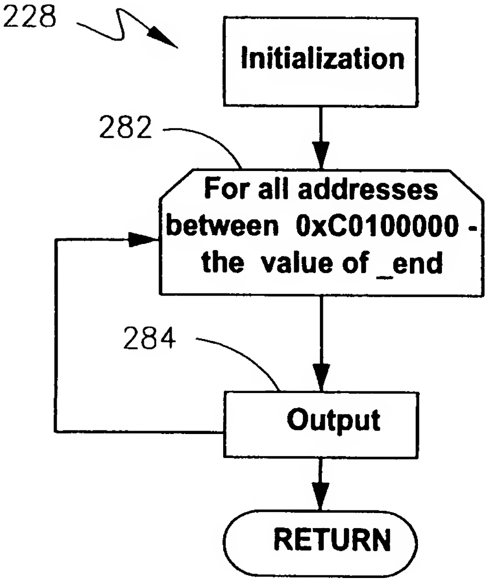
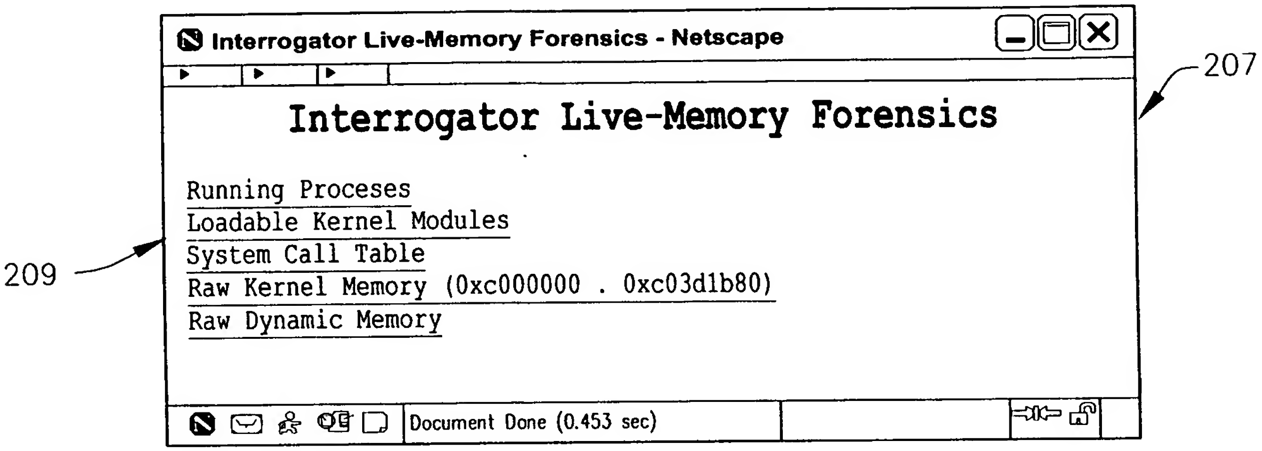


Fig.28c

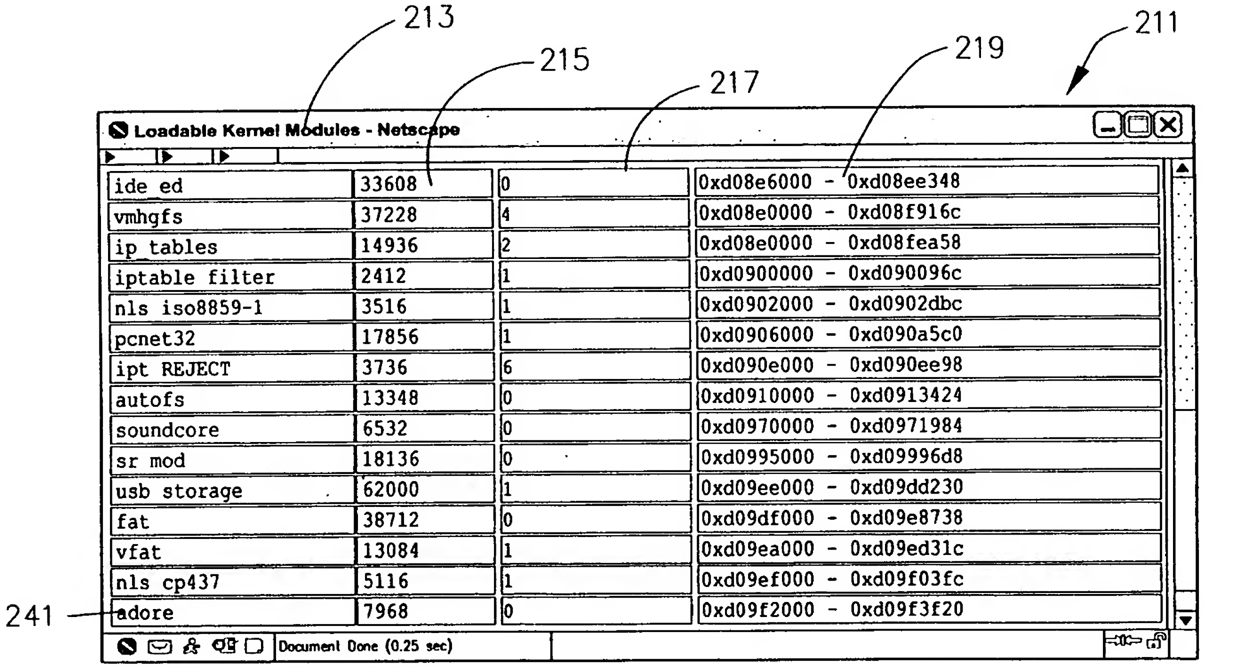


Interrogator Live-Memory Forensics

Running Proceses
Loadable Kernel Modules
System Call Table
Raw Kernel Memory (0xc000000 . 0xc03d1b80)
Raw Dynamic Memory

Document Done (0.453 sec)

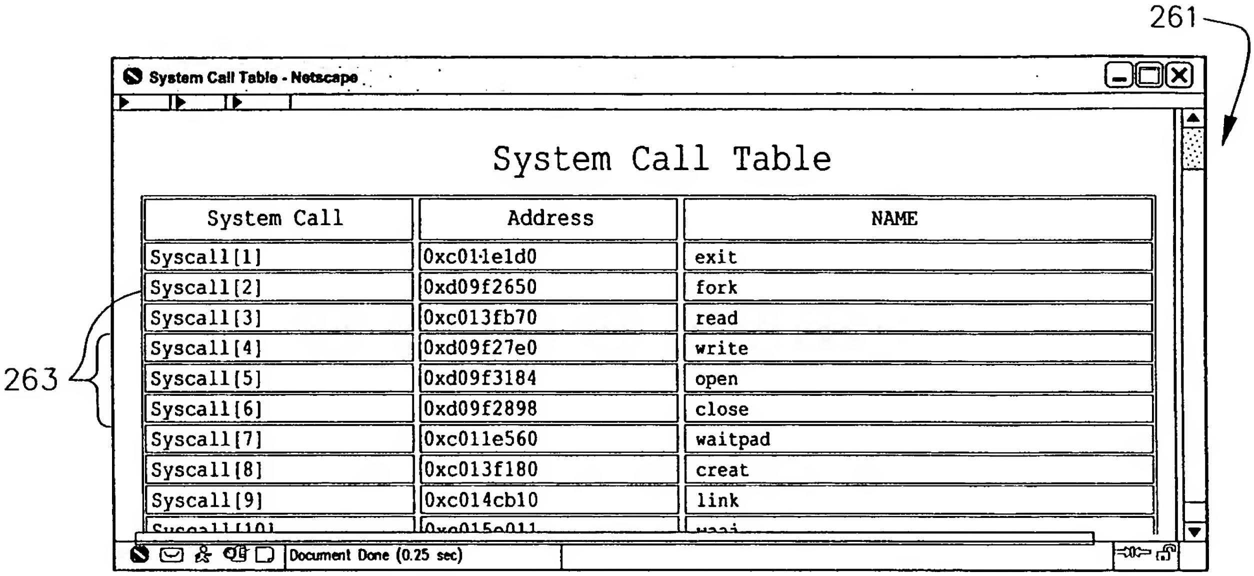
Fig.22b



ide ed	33608	0	0xd08e6000 - 0xd08ee348
vmhgfs	37228	4	0xd08e0000 - 0xd08f916c
ip tables	14936	2	0xd08e0000 - 0xd08fea58
iptable filter	2412	1	0xd0900000 - 0xd090096c
nls iso8859-1	3516	1	0xd0902000 - 0xd0902dbc
pcnet32	17856	1	0xd0906000 - 0xd090a5c0
ipt REJECT	3736	6	0xd090e000 - 0xd090ee98
autofs	13348	0	0xd0910000 - 0xd0913424
soundcore	6532	0	0xd0970000 - 0xd0971984
sr mod	18136	0	0xd0995000 - 0xd09996d8
usb storage	62000	1	0xd09ee000 - 0xd09dd230
fat	38712	0	0xd09df000 - 0xd09e8738
vfat	13084	1	0xd09ea000 - 0xd09ed31c
nls cp437	5116	1	0xd09ef000 - 0xd09f03fc
adore	7968	0	0xd09f2000 - 0xd09f3f20

Document Done (0.25 sec)

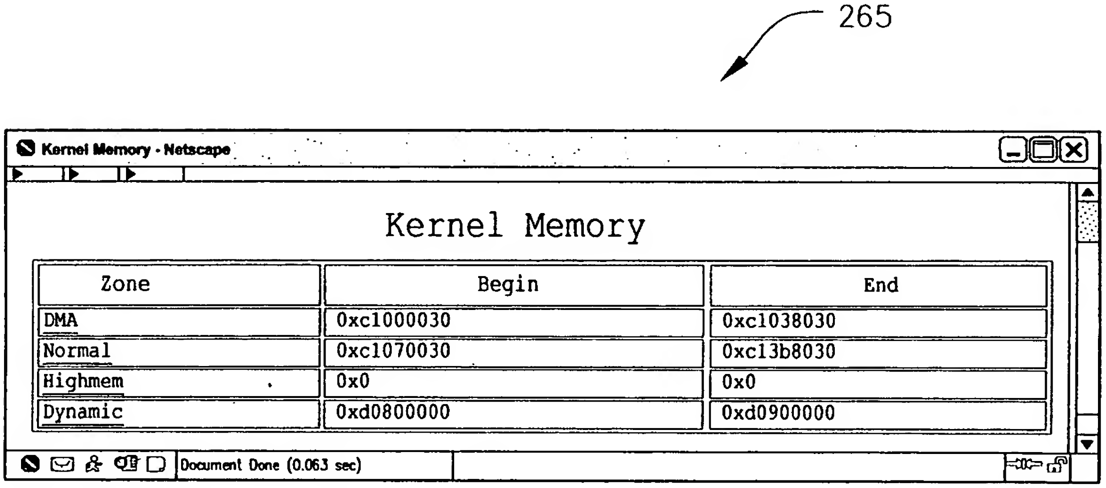
Fig.25b



System Call Table

System Call	Address	NAME
Syscall[1]	0xc011e1d0	exit
Syscall[2]	0xd09f2650	fork
Syscall[3]	0xc013fb70	read
Syscall[4]	0xd09f27e0	write
Syscall[5]	0xd09f3184	open
Syscall[6]	0xd09f2898	close
Syscall[7]	0xc011e560	waitpad
Syscall[8]	0xc013f180	creat
Syscall[9]	0xc014cb10	link

Fig.27b



Kernel Memory

Zone	Begin	End
DMA	0xc1000030	0xc1038030
Normal	0xc1070030	0xc13b8030
Highmem	0x0	0x0
Dynamic	0xd0800000	0xd0900000

Fig.28b

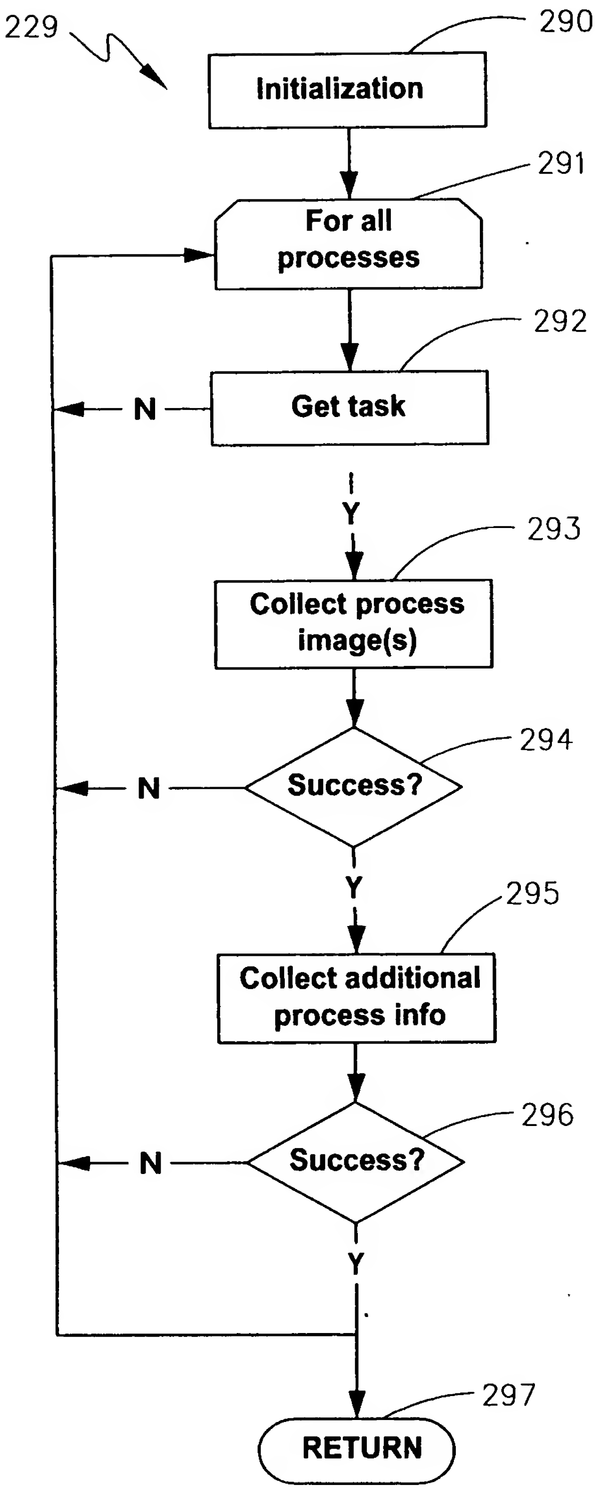


Fig.29a

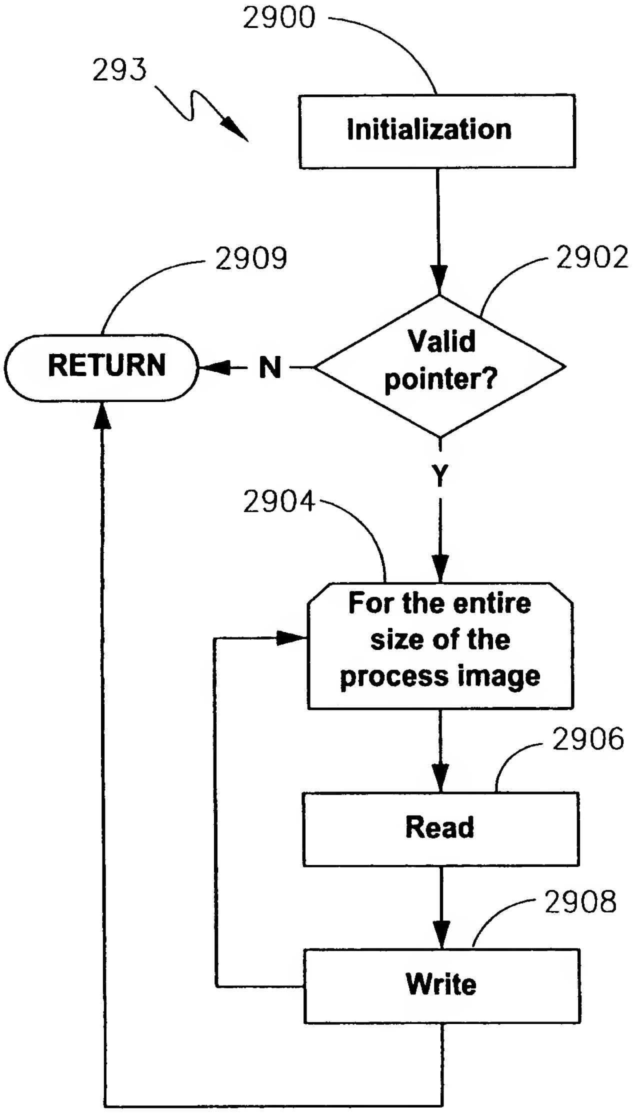


Fig.29b

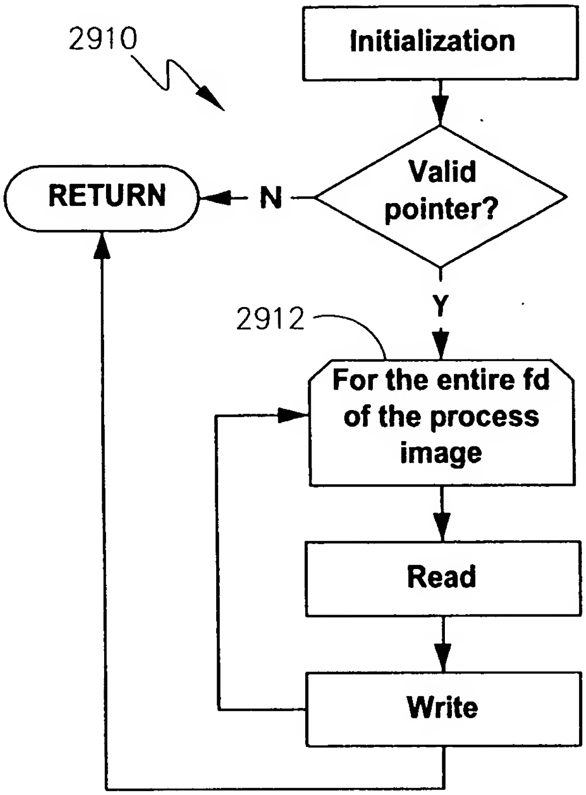


Fig.29c

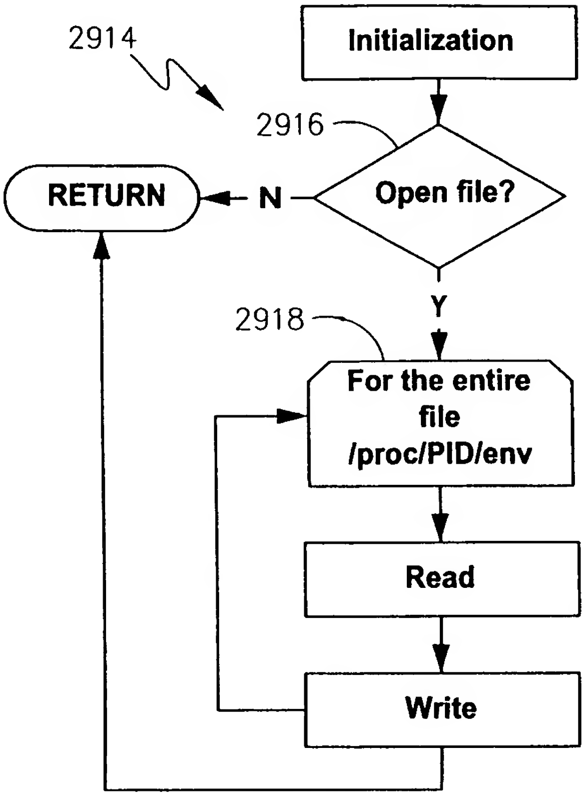


Fig.29d

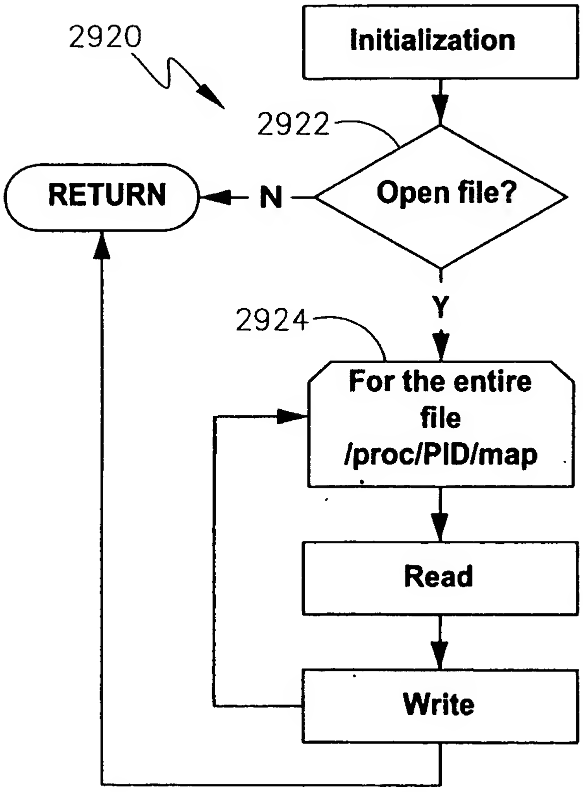


Fig.29e

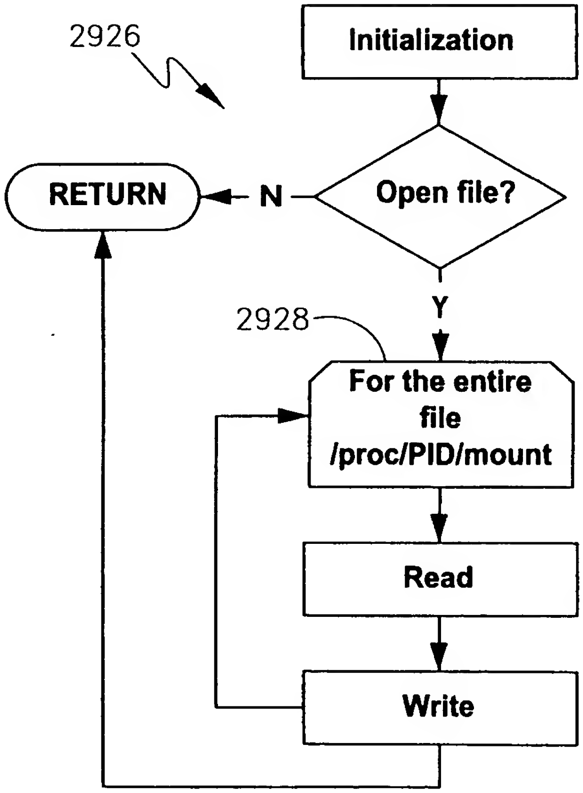


Fig.29f

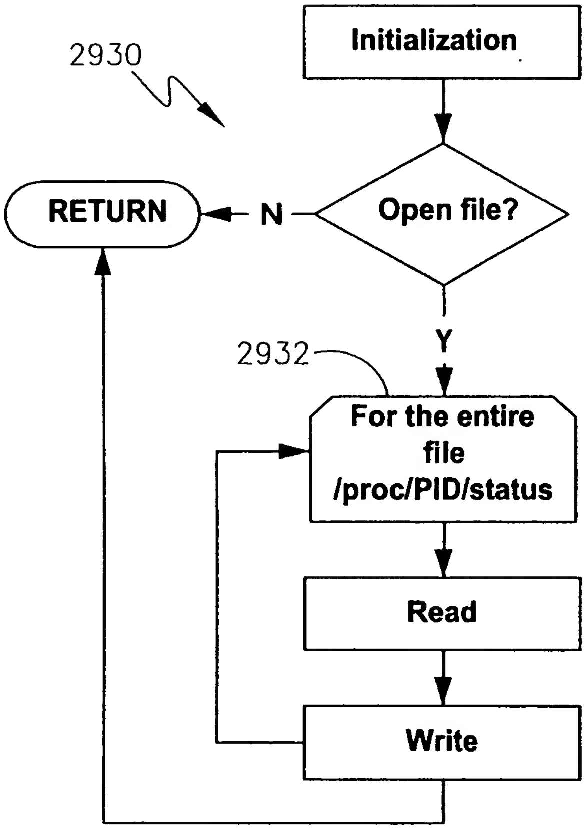


Fig.29g

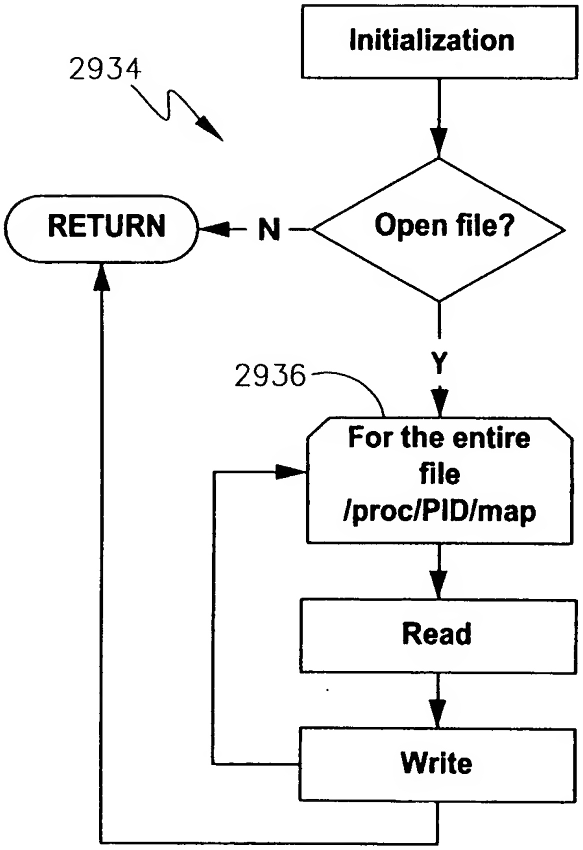
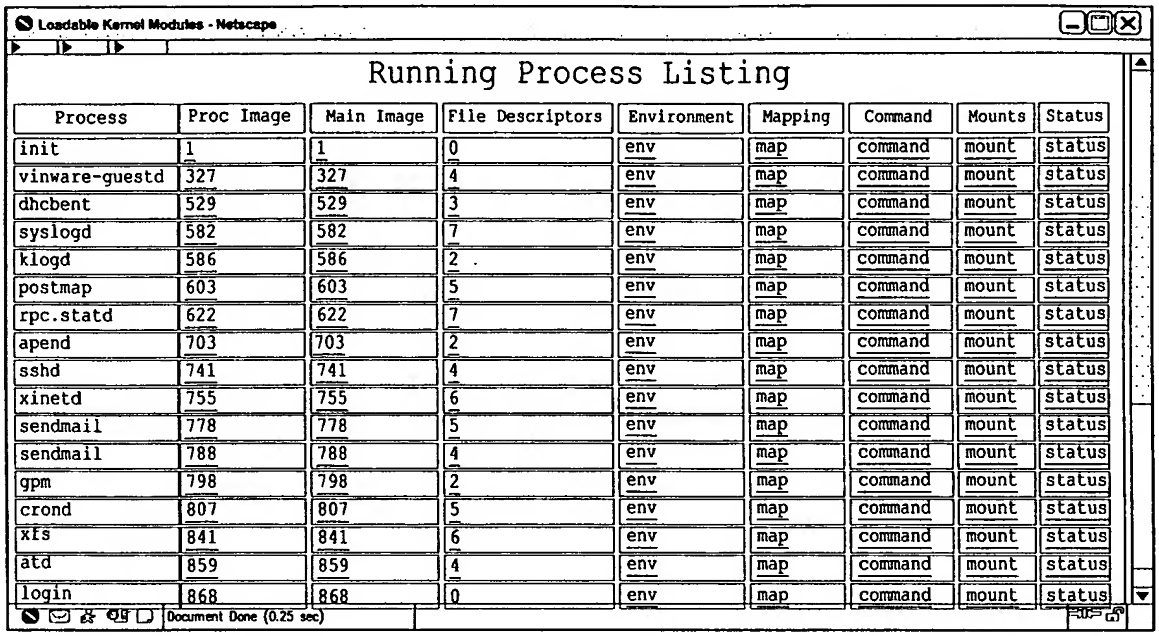


Fig.29h



Running Process Listing

Process	Proc Image	Main Image	File Descriptors	Environment	Mapping	Command	Mounts	Status
init	1	1	0	env	map	command	mount	status
vinware-guestd	327	327	4	env	map	command	mount	status
dhcbent	529	529	3	env	map	command	mount	status
syslogd	582	582	7	env	map	command	mount	status
klogd	586	586	2	env	map	command	mount	status
postmap	603	603	5	env	map	command	mount	status
rpc.statd	622	622	7	env	map	command	mount	status
apend	703	703	2	env	map	command	mount	status
sshd	741	741	4	env	map	command	mount	status
xinetd	755	755	6	env	map	command	mount	status
sendmail	778	778	5	env	map	command	mount	status
sendmail	788	788	4	env	map	command	mount	status
gpm	798	798	2	env	map	command	mount	status
crond	807	807	5	env	map	command	mount	status
xfs	841	841	6	env	map	command	mount	status
atd	859	859	4	env	map	command	mount	status
login	868	868	0	env	map	command	mount	status

267

Fig.29i

269

```
total 13696
drwxr-xr-x      2  root      4096    Jan  5    19:41 .
drwxr-xr-x     11  root      4096    Jan  5    22:26 ..
-rwxr-xr-x      1  root     33960    Jan  5    19:40 1.exe
-rwxr-xr-x      1  root     33960    Jan  5    19:40 1.mem_exe
-rwxr-xr-x      1  root    103165    Jan  5    19:40 327.exe
-rwxr-xr-x      1  root    103165    Jan  5    19:40 327.mem_exe
-rwxr-xr-x      1  root    390950    Jan  5    19:40 529.exe
-rwxr-xr-x      1  root    390950    Jan  5    19:40 529.mem_exe
-rwxr-xr-x      1  root     33635    Jan  5    19:40 582.exe
-rwxr-xr-x      1  root     33635    Jan  5    19:40 582.mem_exe
-rwxr-xr-x      1  root     28571    Jan  5    19:40 586.exe
-rwxr-xr-x      1  root     28571    Jan  5    19:40 586.mem_exe
-rwxr-xr-x      1  root     40144    Jan  5    19:40 603.exe
-rwxr-xr-x      1  root     38147    Jan  5    19:40 603.mem_exe
```

Fig.30a

271

```
fd:   0   READ-WRITE     /socket:/ (1103)
fd:   1   WRITE-ONLY     /var/log/messages
fd:   2   WRITE-ONLY     /var/log/secure
fd:   3   WRITE-ONLY     /var/log/maillog
fd:   4   WRITE-ONLY     /var/log/cron
fd:   5   WRITE-ONLY     /var/log/spooler
fd:   6   WRITE-ONLY     /var/log/boot.log
```

Fig.30b

```
SSH_AGENT_PID=4606
HOSTNAME=string-1.internal.vlan.iwc.sytexinc.com
PVM_RSH=/usr/bin/rsh
SHELL=/bin/bash
TERM=xterm
HISTSIZE=1000
GTK_RC_FILES=/etc/gtc/gtkc:/root//gtkrc-1.2-gnome2
WINDOWID=27270368QTDIR=/usr/lib/qt-3.1
USER=root
LS_COLORS=
PVM_ROOT=/usr/share/pvm3
SSH_AUTH_SOCK=/tmp/sh=XX3Bs0yB/agent.4542
SESSION_MANAGER=local/sring-1.internal.vlan.iwc.sytexinc.com:/tmp/.ICE-
unix/4542
USERNAME=root
MAIL=/var/spool/mail/root
PATH=/usr/kerberos/sbin:/usr/kerberos/bin:/usr/local/sbin:/usr/local/bin:/sbin
:/bin:/usr/sbin:/usr/bin:/usr/X11R6/bin:/root/bin:usr/local/netscape
INPUTRC=/etc/inputrc
PWD=/root
XMODIFIERS=@im-none
LANG=en_US.UTF-8
LAMHELPFILE=/etc/lam/lam-helpfile
GDMSESSION=Default
SH_ASKPASS=/usr/libexec/openssh/gnome-ssh-askpass
HOME=/root
SHLVL=2X
PVM_ROOT=/usr/share/pvm3/xpvm
GNOME_DESKTOP_SESSION_ID=Default
BASH_ENV=/root/.bashrc
LOGNAME=root
LESSOPEN=|/usr/bin/lesspipe.sh %s
DISPLAY=:0.0G
BROKEN_FILENAMES=1
COLORTERM=gnome-terminal
XAUTHORITY=/root/.Xauthority_=/usr/bin/ssh
```

Fig.30c

```
rootfs   /   rootfs    rw  0  0
/dev/root / ext3    ro  0  0
/proc  /proc  proc  rw  0  0
usbdevfs /proc/bus/usb  usbdevfs  rw  0  0
/dev/sdal /boot ext3 rw 0  0
none /dev/pts devpts rw 0  0
none /dev/shm tmpfs  rw 0  0
none /mnt/hgfs vmware-hgfs  rw,nosuid,nodev  0  0
/dev/sdbl /mnt  vfat rw 0  0
```

Fig.30d

```
Name:    vmware-guestd
State:   R  (running)
Tgid:    327
Pid:     327
PPid:    1
TracePid:   0
Uid:     0    0    0    0
Gid:     0    0    0    0
FDSize:  32
Groups:
VmSize:      1424 kb
VmLck:          0kb
VmRSS:        444 kb
VmData:        48 kb
VmStk:          8 kb
VmExe:         84 kb
VmLib:       1252 kb
SigPnd:  0000000000000000
SigBlk:  0000000000000000
SigIgn:  8000000000000000
SigCgt:  0000000000004a07
CapIng:  0000000000000000
CapPrm:  00000000fffffeff
CapEff:  00000000fffffeff
```

Fig.30e

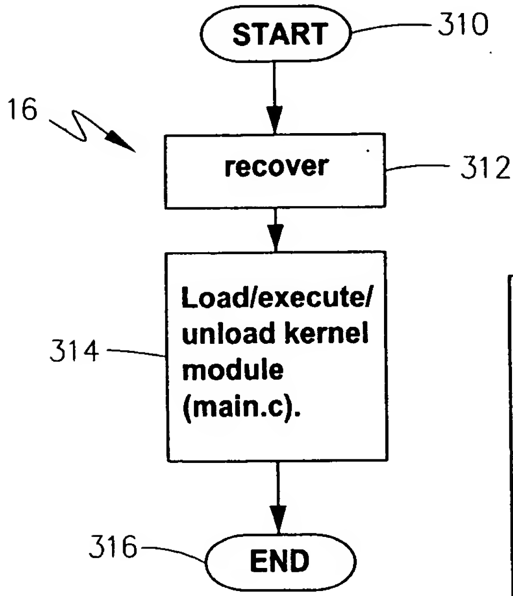


Fig.31

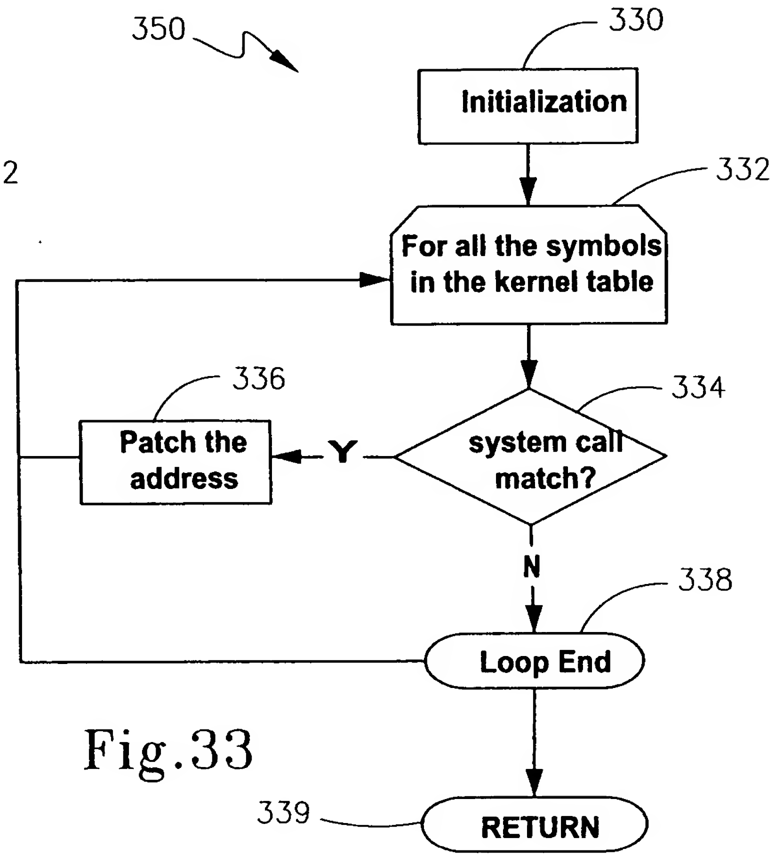


Fig.33

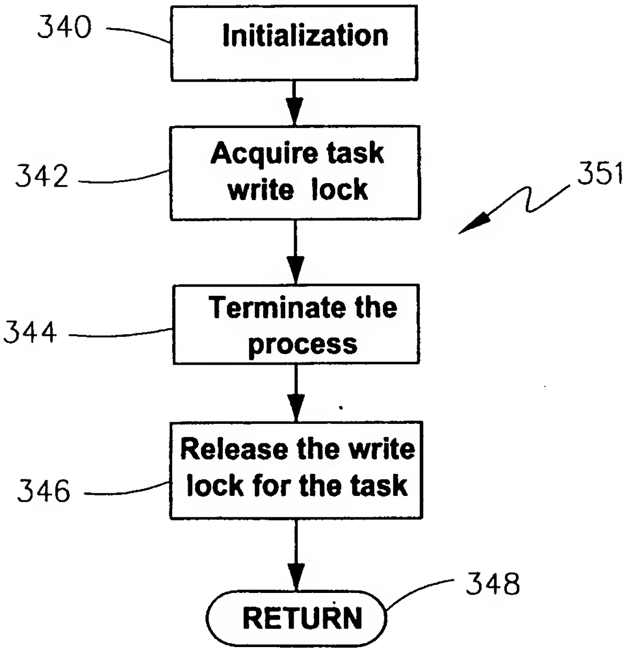


Fig.34

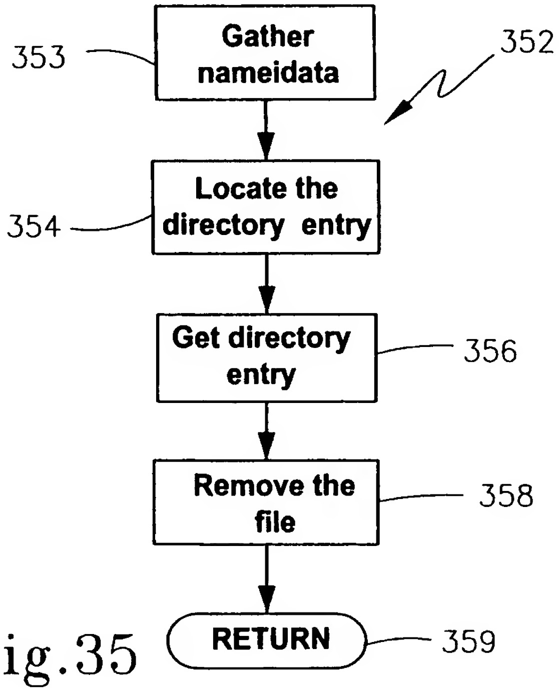


Fig.35

METHODOLOGY, SYSTEM, COMPUTER READABLE MEDIUM, AND PRODUCT PROVIDING A SECURITY SOFTWARE SUITE FOR HANDLING OPERATING SYSTEM EXPLOITATIONS
Applicant: Sandra E. Ring et al.
Serial No.: 10/789,460
Docket No.: 2037

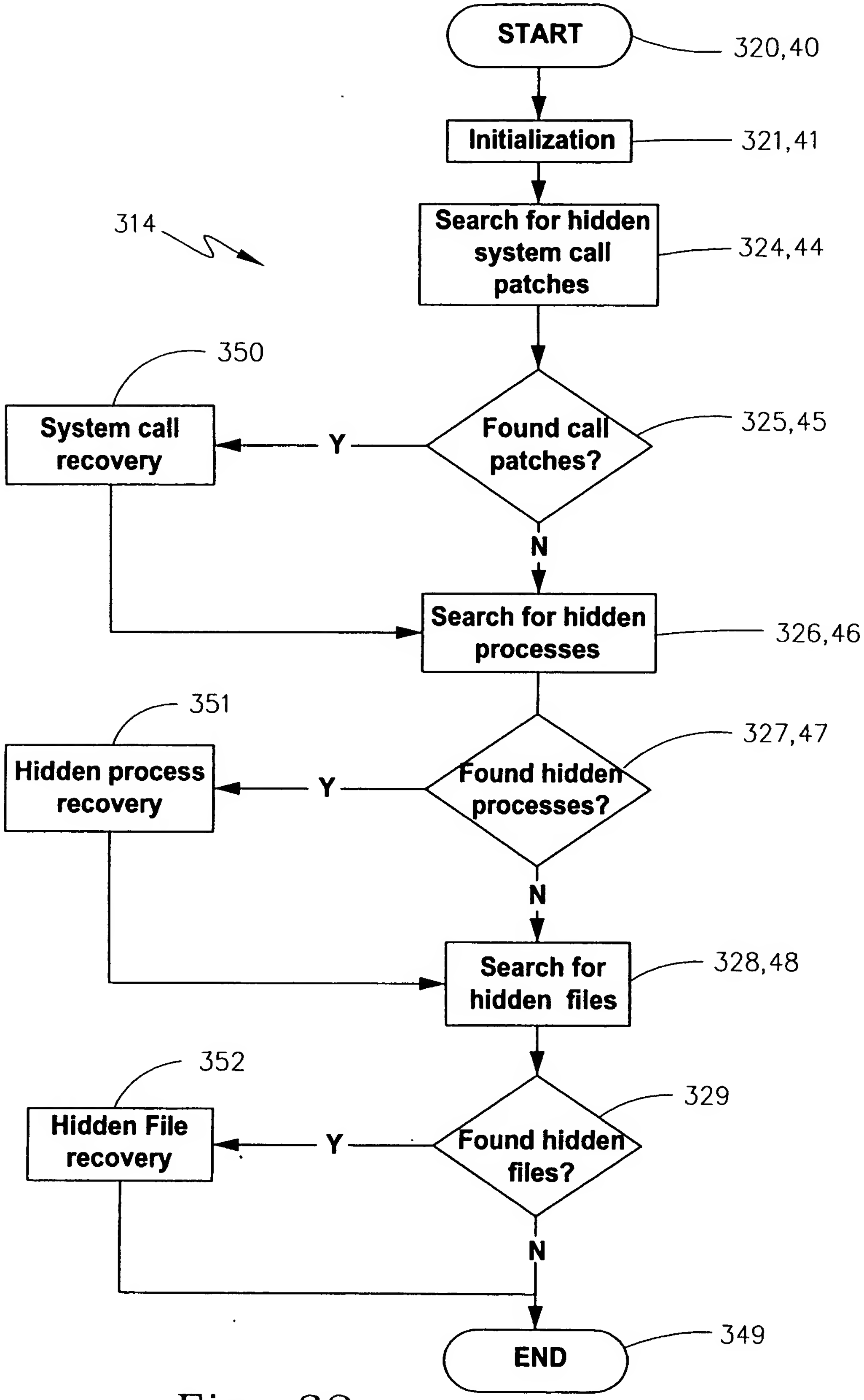
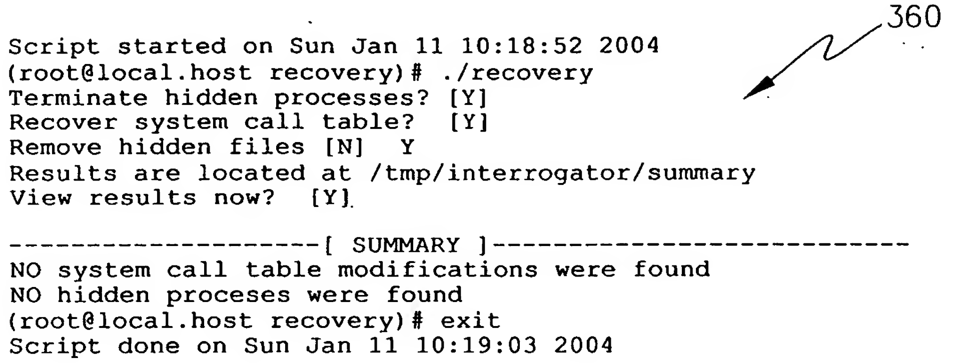
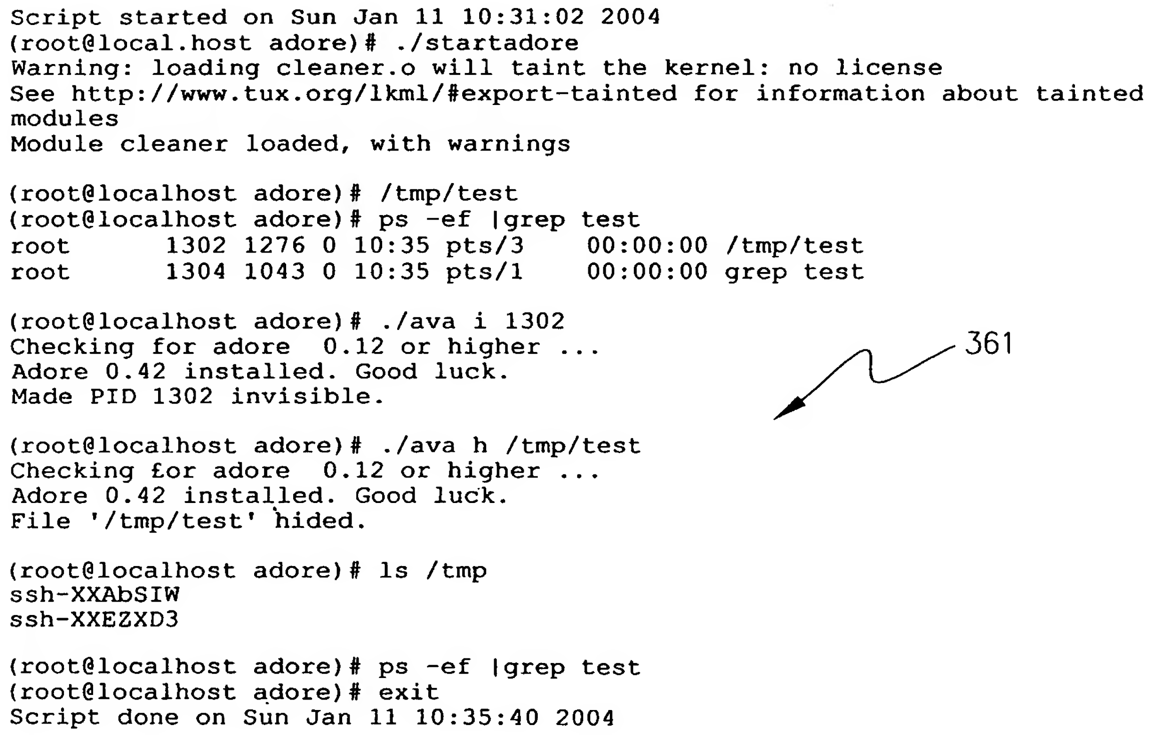


Fig. 32



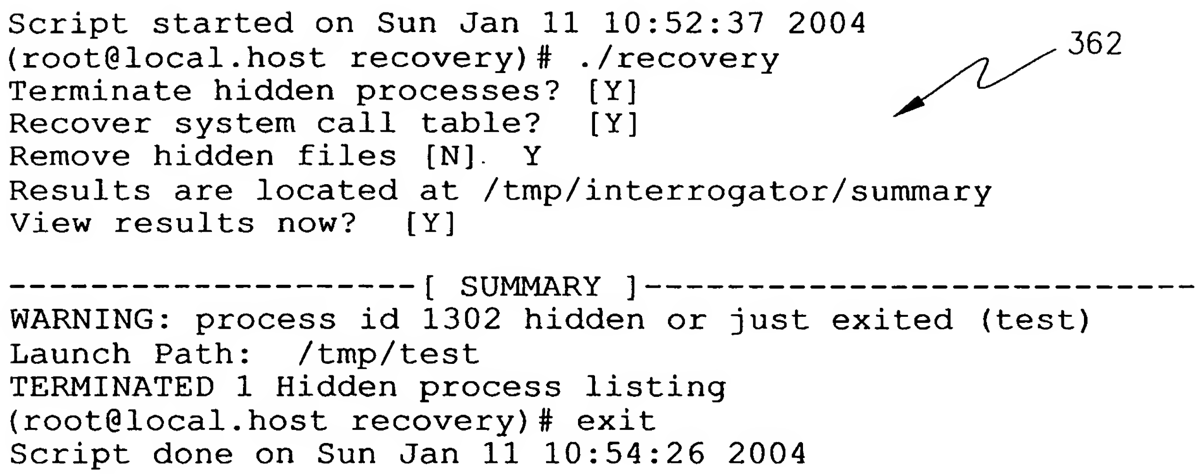
```
Script started on Sun Jan 11 10:18:52 2004
(root@local.host recovery)# ./recovery
Terminate hidden processes? [Y]
Recover system call table?  [Y]
Remove hidden files [N]  Y
Results are located at /tmp/interrogator/summary
View results now?  [Y]

--------------------[ SUMMARY ]--------------------------
NO system call table modifications were found
NO hidden proceses were found
(root@local.host recovery)# exit
Script done on Sun Jan 11 10:19:03 2004
```

Fig.36a



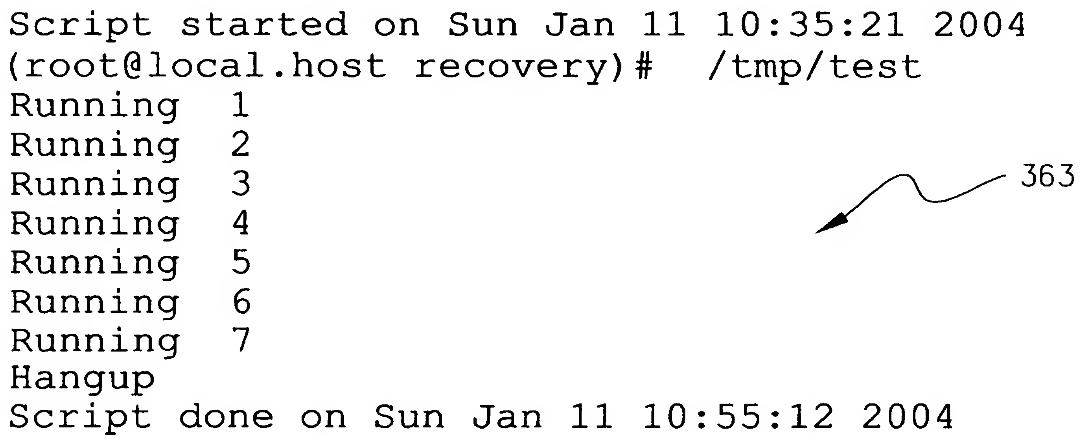
```
Script started on Sun Jan 11 10:31:02 2004
(root@local.host adore)# ./startadore
Warning: loading cleaner.o will taint the kernel: no license
See http://www.tux.org/lkml/#export-tainted for information about tainted
modules
Module cleaner loaded, with warnings

(root@localhost adore)# /tmp/test
(root@localhost adore)# ps -ef |grep test
root       1302 1276 0 10:35 pts/3    00:00:00 /tmp/test
root       1304 1043 0 10:35 pts/1    00:00:00 grep test

(root@localhost adore)# ./ava i 1302
Checking for adore  0.12 or higher ...
Adore 0.42 installed. Good luck.
Made PID 1302 invisible.

(root@localhost adore)# ./ava h /tmp/test
Checking for adore  0.12 or higher ...
Adore 0.42 installed. Good luck.
File '/tmp/test' hided.

(root@localhost adore)# ls /tmp
ssh-XXAbSIW
ssh-XXEZXD3

(root@localhost adore)# ps -ef |grep test
(root@localhost adore)# exit
Script done on Sun Jan 11 10:35:40 2004
```

Fig.36b



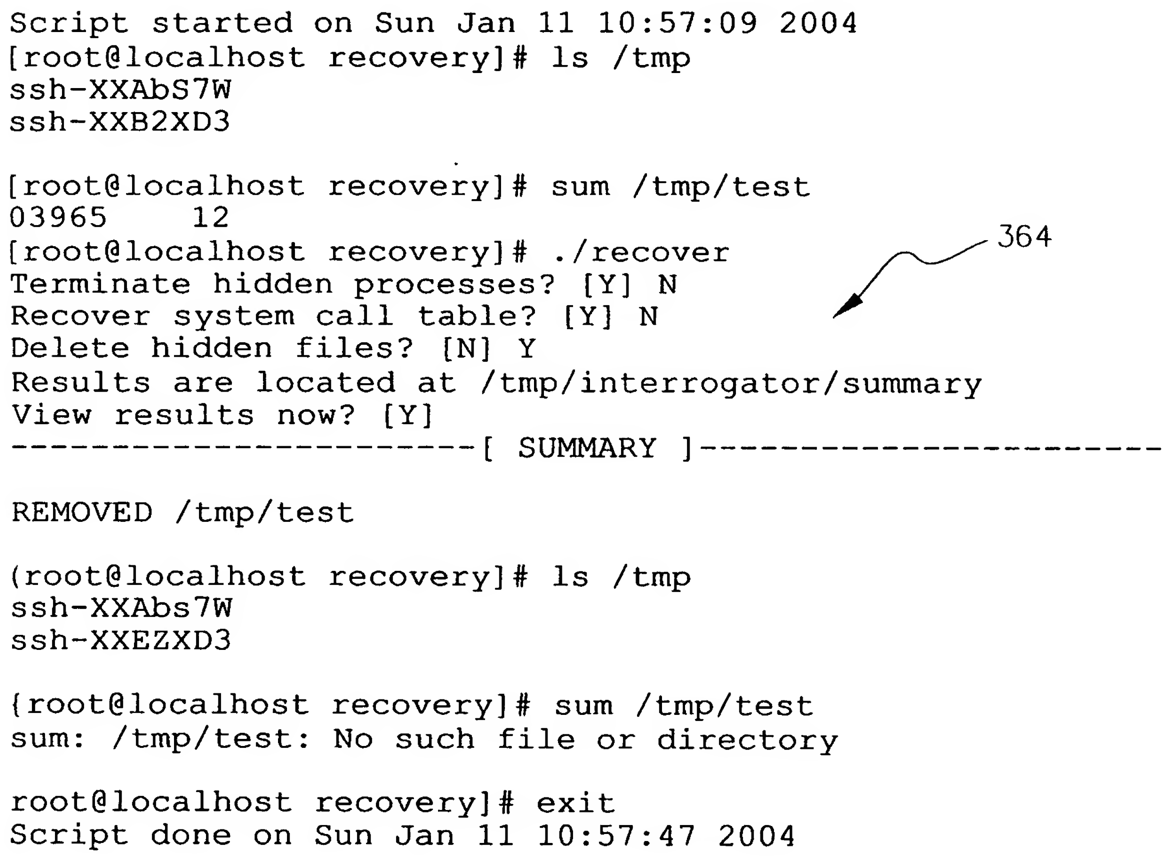
```
Script started on Sun Jan 11 10:52:37 2004
(root@local.host recovery)# ./recovery
Terminate hidden processes? [Y]
Recover system call table?  [Y]
Remove hidden files [N]  Y
Results are located at /tmp/interrogator/summary
View results now?  [Y]

--------------------[ SUMMARY ]---------------------------
WARNING: process id 1302 hidden or just exited (test)
Launch Path:  /tmp/test
TERMINATED 1 Hidden process listing
(root@local.host recovery)# exit
Script done on Sun Jan 11 10:54:26 2004
```

Fig.36c



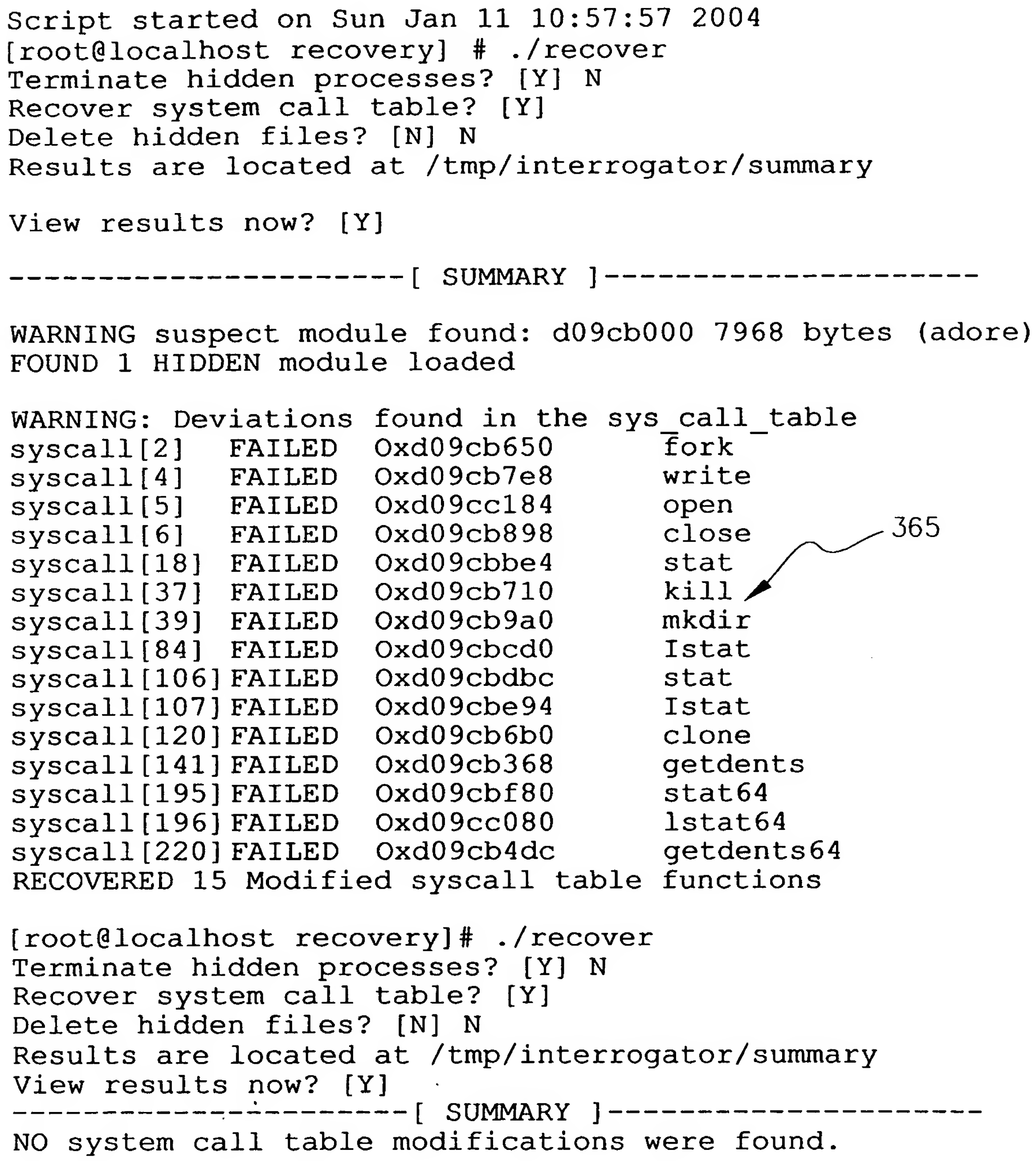
```
Script started on Sun Jan 11 10:35:21 2004
(root@local.host recovery)#  /tmp/test
Running  1
Running  2
Running  3
Running  4
Running  5
Running  6
Running  7
Hangup
Script done on Sun Jan 11 10:55:12 2004
```

Fig.36d



```
Script started on Sun Jan 11 10:57:09 2004
[root@localhost recovery]# ls /tmp
ssh-XXAbS7W
ssh-XXB2XD3

[root@localhost recovery]# sum /tmp/test
03965    12
[root@localhost recovery]# ./recover
Terminate hidden processes? [Y] N
Recover system call table? [Y] N
Delete hidden files? [N] Y
Results are located at /tmp/interrogator/summary
View results now? [Y]
----------------------[ SUMMARY ]-----------------------

REMOVED /tmp/test

(root@localhost recovery]# ls /tmp
ssh-XXAbs7W
ssh-XXEZXD3

{root@localhost recovery]# sum /tmp/test
sum: /tmp/test: No such file or directory

root@localhost recovery]# exit
Script done on Sun Jan 11 10:57:47 2004
```

Fig.36e



```
Script started on Sun Jan 11 10:57:57 2004
[root@localhost recovery] # ./recover
Terminate hidden processes? [Y] N
Recover system call table? [Y]
Delete hidden files? [N] N
Results are located at /tmp/interrogator/summary

View results now? [Y]

----------------------[ SUMMARY ]---------------------

WARNING suspect module found: d09cb000 7968 bytes (adore)
FOUND 1 HIDDEN module loaded

WARNING: Deviations found in the sys_call_table
syscall[2]   FAILED  0xd09cb650      fork
syscall[4]   FAILED  0xd09cb7e8      write
syscall[5]   FAILED  0xd09cc184      open
syscall[6]   FAILED  0xd09cb898      close
syscall[18]  FAILED  0xd09cbbe4      stat
syscall[37]  FAILED  0xd09cb710      kill
syscall[39]  FAILED  0xd09cb9a0      mkdir
syscall[84]  FAILED  0xd09cbcd0      Istat
syscall[106] FAILED  0xd09cbdbc      stat
syscall[107] FAILED  0xd09cbe94      Istat
syscall[120] FAILED  0xd09cb6b0      clone
syscall[141] FAILED  0xd09cb368      getdents
syscall[195] FAILED  0xd09cbf80      stat64
syscall[196] FAILED  0xd09cc080      lstat64
syscall[220] FAILED  0xd09cb4dc      getdents64
RECOVERED 15 Modified syscall table functions

[root@localhost recovery]# ./recover
Terminate hidden processes? [Y] N
Recover system call table? [Y]
Delete hidden files? [N] N
Results are located at /tmp/interrogator/summary
View results now? [Y]
----------------------[ SUMMARY ]---------------------
NO system call table modifications were found.
```

Fig.36f

```
Script started on Sun Jan 11 11:31:47 2004
[root@localhost adore]# ps -ef |grep test
root   1284 1258 0 11:31 pts/1    00:00:00 /tmp/test

[root@localhost adore]# ls /tmp
ssh-XXAbS7W
ssh-XXEZXD3
test

[root@localhost adore]# ./startadore
Warning: loading cleaner.o will taint the kernel: no license
See http://www.tux.org/lkml/#export-tainted for information about tainted
modules
Module cleaner loaded, with warnings

[root@localhost adore]# ./ava i 1284
Checking for adore  0.12 or higher ...
Adore 0.42 installed. Good luck.
Made PID 1284 invisible.

[root@localhost adore]# ./ava h /tmp/test
Checking for adore  0.12 or higher ...
Adore 0.42 installed. Good luck.
File '/tmp/test' hided.

(root@localhost adore]# ps -ef |grep test
(root@localhost adore]# ls /tmp
ssh-XXAbS7W
ssh-XXEZXD3

[root@localhost adore]# cd ../interrogator/recovery
[root@localhost recovery]# ./recover
Terminate hidden processes? [Y] N
Recover system call table? [Y] Y
Delete hidden files? [N] N
Results are located at /tmp/interrogator/summary
View results now? [Y]
----------------------[ SUMMARY ]---------------------
WARNING suspect module found: d09cb000 7968 bytes (adore)
FOUND 1 HIDDEN module loaded

WARNING: Deviations found in the sys_call_table
syscall[2]      FAILED  Oxd09cb650     fork
syscall[4]      FAILED  Oxd09cb7e8     write
syscall[5]      FAILED  Oxd09cc184     open
syscall[6]      FAILED  Oxd09cb898     close
syscall[18]     FAILED  Oxd09cbbe4     stat
syscall[37]     FAILED  Oxd09cb710     kill
syscall[39]     FAILED  Oxd09cb9a0     mkdir
syscall[84]     FAILED  Oxd09cbcd0     Istat
syscall[106]    FAILED  Oxd09cbdbc     stat
syscall[107]    FAILED  Oxd09cbe94     Istat
syscall[120]    FAILED  Oxd09cb6b0     clone
syscall[141]    FAILED  Oxd09cb368     getdents
syscall[195]    FAILED  Oxd09cbf80     stat64
syscall[196]    FAILED  Oxd09cc080     lstat64
syscall[220]    FAILED  Oxd09cb4dc     getdents64
RECOVERED 15 Modified syscall table functions

[root@localhost recovery]# ps -ef |grep test
root      1284  1258  0 11:31 pts/1    00:00:00 /tmp/test
root      1345  1288  0 11:33 pts/2    00:00:00 grep test

[root@localhost recovery]# ls /tmp
ssh-XXAbS7W
ssh-XXS2XD3
test

[root@localhost recovery]# exit

Script done on Sun Jan 11 11:33:21 2004
```

366

Fig.36g